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Basic Research in China Undergoing Profound Change

40080154b Shanghai JIEFANG RIBAO in Chinese 14 Feb 89 p 3

[Article by Chen Jinwu [7115 6855 2976]]

[Text] According to an investigative report of the Basic Research Investigation Group, basic research in China is undergoing profound changes under the policy of reform and openness.

The investigation conducted by units including the State Science Council showed that China's basic research has changed along with reforms in the science and technology system. The main characteristics are described below:

A number of research institutes charged mainly with basic research was established and a number of research facilities was strengthened. Research institutes devoted mainly to basic research in the Chinese Academy of Sciences system has reached 32 in number. There are almost 1500 various types of research institutes and laboratories in the colleges and universities.

Major disciplines have been strengthened and new areas developed. In recent years a number of disciplines have made major advances and shortened the distance towards international level; these include microbiology, cell biology, molecular electronics, biomedical engineering, surface physics and chemistry, biological inorganic chemistry, molecular reaction kinetics, high temperature superconductors, super lattice and quasi-crystalline physics, fuzzy mathematics, and others.

Full fledged complete research teams have been formed in major scientific fields. Statistics showed that in 1986 there were 19,700 workers in China's basic research team and the number has increased to 30,000 in 1987. Combining basic research and applied research, there were almost 100,000 people in China in 1987.

The scale and funding in basic research have increased. In major scientific engineering projects recently completed or under construction, 11 projects are greater than 10 million yuan each and the total investment is 650 million yuan. National high priority laboratories already completed or under construction number 55, at a total investment of 430 million yuan. Basic research topics have also increased in number and funding. In 1987 there were 20,000 basic research projects in China. The total investment in basic research in China has reached 800 million, or 7.1 percent of the science and technology allocation in China in that year.

Important results have been obtained in basic research. Prominent examples are high temperature superconductors, stability of differential kinetic system, genetic engineering breakthroughs in vaccine for hepatitis B, and a number of novel crystals.

The international stature of Chinese scientists has risen, 364 Chinese scientists are carrying out official duties in international academic organizations, and the number of scientists visiting foreign countries has increased. The number of papers published by Chinese scientists on major international journals has moved from 35th place in 1980 to 24th place in 1987, and the number of papers given in international meetings reached 14th place in 1986 and 1987.

Zhou Guangzhao's Speech At National Conference On Basic Research and Applied Basic Research

40080153 Beijing KEJI BAO in Chinese 15 Feb 89 p 1

[Speech by Zhou Guangzhao [0719 0342 0664]: "Historical Responsibilities of Chinese Scientists--Excerpts From His Speech at the National Basic Research and Applied Basic Research Work Conference, 13 February 1989"]

[Text] China is now at a key historical juncture. We have made magnificent achievements which have attracted world attention in reforms and opening up in the last 10 years, and they have brought hope of rejuvenating the Chinese nationality. However, we have a large population which is growing too fast and our per capita levels of cultivated land, water resources, energy resources, primary metals, and so on are below the world averages. Food and raw materials shortages, severe environmental pollution, ecological degradation, and other things have created grim conditions which restrict further development. The process involved in the transition from old to new systems has generated friction, conflicts, faults, universally multiplying and leading consumption, extravagant waste and unhealthy tendencies, eating out of the big common pot and iron rice bowl, and a sense consciousness. All these things have made progress more difficult.

The advanced nations continue to make progress. If an economically backward big nation wishes to catch up, it must work harder, regulate the utilization of manpower, materials, and funds in a more planned fashion, conform better to objective laws, use the advantages of late development, and seize development opportunities. It must pay more attention to using the strength of spirit to motivate the initiative of the masses to achieve the goal of unanimity of all people and long-term unremitting efforts. China's future depends on relying on S&T and arduous struggle to grasp fleeting opportunities, and there is the real possibility that the opportunities may be missed, resulting in renewed backwardness. China's rejuvenation depends on all of our people uniting with one heart in long-term struggle. S&T workers and educators have an even more special historical responsibility.

The 13th CPC Central Committee proposed giving primacy to S&T and education in economic construction and placing China's hopes for social progress and economic prosperity on S&T and education. This is the strongest call for Chinese society to orient itself toward S&T and education. Everyone has a share of responsibility for the fate of their country, and China's scientists and educators are duty-bound to accept this sacred mission.

In the 1950's, Mr. Ma Yinchu [7456 1377 0443] scientifically analyzed the socioeconomic effects of China's population growth and proposed the idea of family planning. His scientific foresight has been confirmed by the course of Chinese history. Regrettably, his opinions were not accepted at the time. China's population is now 1.1 billion and is expected to be 1.3 billion by the end of this century. The enormous and sustained growth of a population with low cultural, scientific, and technical levels has become the greatest problem facing modernization and progress in China, and pressures from its continued existence point toward resource shortages and growing environmental degradation. This is particularly obvious for the agricultural land and water resources which assure our food supplies. Some environmental scholars and ecologists in China are sounding serious alarms to society. China's environment is now being destroyed by man's activities, and there is severe degradation and pollution. Almost one-third of our area suffers from soil erosion which removes 5 billion tons of silt each year. Our forests are shrinking and our timber consumption each year exceeds the amount grown by nearly 100 million m^3. Reverted grasslands in China cover an area of 770 million mu. Deserts are growing by about 1,500 km^2 each year and now cover 11.4 percent of China's area. Pollution is spreading from cities to the countryside and about 150 million people are drinking polluted water. Acid rain has appeared in southwest China, and Beijing and other cities have become smog capitals. We are facing the grimmest ecological destruction and environmental pollution in our history. Without decisive action, the basis of the existence of the Chinese nationality is threatened.

The contradiction between our population and our resources and environment will vex Chinese society for a long time to come. The only solution is to rely on S&T progress and long-term hard work, thrift, and conservation to develop our economy and other endeavors.

Surplus labor power creates employment problems, but it also is China's most important latent advantage. This advantage can be realized only by improving our cultural, scientific, technical, and ethical qualities. A major responsibility of China's scientists is to promote the development of education and popularize scientific knowledge to convert the heavy millstone of China's population into a powerful motive force.

Beginning with China's national conditions, the main efforts of S&T circles should be focused on serving our national economy at the present time. We must always be concerned with rational utilization of our land and resources, control the environment, protect the ecology, and develop energy conservation and S&T to conserve water and raw materials. We should apply the newest

achievements in the engineering and technical sciences for continual improvement of traditional technology and industry. Employment pressures force us to focus on developing labor-intensive industries to exchange our cheap labor power for limited capital and expensive equipment. However, high-tech industries established on the basis of the newest S&T which can compete in international markets are the key to our future economic takeoff, elimination of poverty, and entrance into modern society. Some among those personnel engaged in leading scientific research who have grasped the newest scientific achievements are leaving their laboratories and dedicating their lives to creating high-tech industries in China. They are writing a song of triumph in China's history that resounds around the world.

Besides fully utilizing its condition of opening up, a large country should establish its own research staffs and research centers to engage in basic research and invigorate the leading edge of scientific research. They are providing S&T preparations for reserve strengths in our national economic development, and they continually train and send out advanced S&T personnel as a contributing force to development of our national economy at the present time. Moreover, international cooperation and competition will bring them glory as representatives of the Chinese nationality in the development of world S&T.

China does not invest much in basic research now, with per capita investments that are just a few tenths or a hundredth of the advanced nations of the world. We must work in every way possible to change this situation. However, we must soberly acknowledge that we cannot set our hopes too high in the short term since due to restrictions by economic development levels and social cognition levels in China. They can only improve as our economy develops over the years. This means that China's basic research goals must be limited, the scale must be appropriate, and the personnel must [be] keen-witted and capable.

To utilize our limited capital and equipment fully and effectively and strengthen our international competitiveness, we must break down departmental boundaries, abandon sectarianism, and use opening up, circulation, integration, and competition to transform existing laboratories and enable China's best scientists to assemble together for exchange, cooperation, and joint promotion of the development of science. We must enable young people to enter the realms of research and to use and display their intellect and talents. We should enable accomplished scientists to shift toward applied development and emerging intersecting disciplines. In the past few years, with support from scientists throughout China, some research institutes and university laboratories have adopted this new type of system and made very good achievements, which is an extremely gratifying change. In the future, we should continue to make society have a better understanding of its own long-term interests and the importance of basic research by solving major problems which appear in economic construction and social development and by using propaganda and education to generate acceptance and support of basic research work. At the same time, we should uphold our own values and standards, adhere to our own dignity and sentiments, and have a spirit of devotion while working in a poor environment in ceaseless struggle for the long-term interests of the motherland.

China's previous generation of scientists and educators have set glorious examples for us. They did not pursue fame during the difficult years and months of war among warlords and the War of Resistance Against Japan, nor did they fear hardship. Instead they dedicated themselves wholly to creating development and scientific research activities for China. After the nation was founded, many scientists gave up their comfortable living and working conditions in foreign countries and returned to China to dedicate themselves to the cause of S&T and education in China. Having such a relatively strong S&T force given China's current economic conditions is one of their main accomplishments.

Middle-aged people will continue to be the primary force and backbone in S&T work for the next 10 years. They have experienced many hardships and twists and turns during their growth process, lost their most valuable time for work and creation, and shouldered heavy family and livelihood burdens. They are a superior workforce which China herself has trained. Being one of them, I deeply understand their hardships and hope they achieve their fervent hope for their own social values in the next decade. Scattered struggles among them of course are necessary, but if they are confined to this, this generation of people may not leave its mark on the history of S&T in China. We should unite and concentrate forces to deal with major scientific issues which appear in S&T and the national economy and take action to promote reforms in the S&T system and open up a new era in the development of S&T in China.

Young people are China's hope. China's many young people who understand modern S&T knowledge are our only latent advantage. A few young people have revealed their great talents and abilities and entered the vanguard of scientific research. They have made outstanding achievements and become the main force and backbone of research. We should encourage those young people who are determined to dedicate their lives to working and living under difficult conditions on Chinese soil. We must break down rigid seniority systems and give them the greatest possible support, and we should require them to acknowledge their historical responsibilities. The banner of the peak of world science unfurled by the Chinese nationality has now been transferred into their hands. We hope they will unite as one and fear no danger in fortifying their will and determination to open a major channel for China's scientific activities to move toward the world.

History and society have issued a call of the times for us to be resolute in our own convictions and values, to wave high the banners of "education" and "science," and to move forward steadily.

Eleven years ago, at the National Science Conference, Guo Lao [6753 5071] praised the arrival of the "scientific" spring. S&T workers throughout China have been arduously cultivating since then, and the seeds of science have sprouted and begun to grow. In another 11 years, we will be facing the 21st century. If we continue to nurture, irrigate, and fertilizer them, the flower of science in China will reveal its glory in the 21st century.

Chinese Scientists Active in Quest for Cold Fusion

40100048 Beijing CHINA DAILY in English 9 May 89 p 5

[Article by Yang Xiaoping]

[Text] As some prestigious American physicists appeal to their colleagues to cool down the fusion fever that has been raging in the scientific world since late March, a group of Chinese scientists from Beijing Normal University are continuing their experiments, aiming to clarify the cold-fusion issue.

In an 15-square-metre laboratory in the university's Institute of Low Energy Nuclear Physics in northwest Beijing, the physicists, together with several chemists, are carrying out their sixth experiment. The first experiment was conducted on April 18, 26 days after Stanley Pons and Martin Fleischmann announced their achievement of nuclear fusion at room temperature in an experiment in Utah, in the United States.

Professor Huang Zuqia, honorary director of the institute and a member of the Chinese Academy of Sciences, said that the Chinese researchers expect to use convincing scientific experiments to prove whether the reported phenomenon was nuclear fusion or not.

Nuclear fusion is the process of fusing two nuclei of light chemical elements to form a heavier nucleus and release energy. It is the reverse of nuclear fission, in which energy is produced by the splitting of heavy atomic nuclei into lighter fragments.

Energy from nuclear fusion was first exploited in a relatively uncontrolled manner in the production of the hydrogen bomb in the early 1950s. Then scientists around the world began to search for ways to produce energy through nuclear fusion in a controlled way, since a fusion reaction could produce a huge amount of energy that would be clean, cheap and virtually inexhaustible.

Later, large devices were constructed with the aim of making nuclear fusion occur in a controlled way, but high temperatures and complex equipment are required. Since the energy is released in a controlled manner and the reaction takes place at a temperature above 100 million degrees Centigrade, the process is described as a "controlled thermonuclear fusion reactions."

The costliness and complexity of working on such a reaction have led scientists to seek another method.

A break-through was announced on March 23 by two electrochemists, Pons of the University of Utah and his British colleague, Fleischmann of the University of Southampton. Based on five years of research, the two electrochemists claim that they achieved fusion in an electrolytic cell containing "heavy water" rich in the hydrogen isotope deuterium. A platinum anode and a palladium cathode were installed in the water.

Pons and Fleischmann said that fusion occurred when deuterium atoms accumulated around the palladium electrode. And they also said that the fusion reaction produced helium and tritium atoms, neutrons and a release of energy. The presence of neutrons, helium and tritium atoms are believed to signify cold fusion.

Because the fusion reaction took place at room temperature, it became known as "cold fusion."

Afterwards, laboratories from many countries began to attempt to corroborate the experiment, which one scientist called "the most important discovery after fire." Then reports of success came from laboratories in Italy, the Soviet Union, Poland, Hungary, Japan and South Korea.

Among the labs that have experimented with cold fusion experiments in China, the Beijing Normal University's Institute of Low Energy Nuclear Physics, the Nuclear Physics and Chemistry Institute under the China National Nuclear Industrial Corporation and the Institute of Chemistry under the Chinese Academy of Sciences first claimed positive results.

Positive results

Scientists from Beijing Normal University claimed that two of their five completed experiments--the second and the fourth--showed positive results. The other three experiments were either disturbed by an accelerator or failed in terms of reaction time.

The apparatus for the experiment was described as being similar to that used by Pons and Fleischmann. They put a palladium cathode and a platinum anode in 200 cubic millimetres of heavy water.

During their second experiment, the scientists counted the production of 100 excess neutrons and 40 excess tritium atoms. And they achieved a better result during their fourth experiment.

"About 23 hours after the beginning of the experiment, we counted 3,312 neutrons and 54 tritium atoms during an hour and a half," a scientist said.

"Some scientists deemed that heavy water in northern China contains tritium, so we can't conclude that the tritium is produced by fusion," the scientist said.

"But if the fourth experiment can be repeated, it means a fusion reaction took place."

Now working with a theoretical model of a cold fusion reaction, Huang said, "If the cold fusion phenomenon was definitely affirmed by experiments, theoretical explanation would not be impossible.

"But we have to be more cautious with our future experiments. We will put questions to ourselves," continued the professor, who has been engaged in nuclear physics research since he graduated from Qinghua University in 1948.

Liu Boli, a chemistry professor at the same university, said that a convincing experiment in cold fusion reaction should be tested by measuring four things: neutrons, gamma rays, tritium and calorimetry.

"Calorimetry measurement is difficult, but we have to do it if we are to achieve a definitely positive result," Huang said.

Even if the experiment is confirmed, he predicted that "we still have a long way to go before it can be put to practical use."

Yang Liming, a physics professor at Beijing University, said that although their results were uncertain, Pons' and Fleischmann's experiment gave nuclear physicits some ideas.

According to the traditional theory in nuclear physics, Yang explained, when two deuterium atoms are at a distance of 10 to the -8 power centimetre from each other, they repel each other. But when they are apart by 10 to the -12 or -13 power centimetre, they attract each other and create a fusion reaction.

The usual method of narrowing the distance between deuterium atoms is to increase pressure and temperature.

But cold fusion tries to increase the density inside a lattice of deuterium atoms so as to create a special environment for the deuterium atoms' attraction.

The source of cold fusion--deuterium--is rich in sea, river or lake water. Scientists say that the deuterium extracted from a cubic metre of sea water could generate as much energy as 10 tons of coal.

"If cold fusion were successful, it would be a great contribution to mankind," Huang said.

Breakthrough Reported in Neodymium-Iron-Boron Permanent-Magnet Materials

40080165a Beijing RENMIN RIBAO in Chinese 29 Mar 89 p 2

[Article by Jiang Jianke [5592 1696 4430]: "Successful Key Project in Neodymium-Iron-Boron Permanent-Magnet Materials--Samples Developed that Take a Leading Place Among World [Laboratories]"]

[Summary] Beijing, 28 Mar--China's key Seventh 5-Year Plan project to develop permanent-magnet materials has had another breakthrough. Scientists Li Wei [2621 5898], Li Bo [2621 3134], and Yu Xiaojun [0827 2556 6511] of the Main Iron & Steel Research Institute of the Ministry of Metallurgical Industry have prepared samples of a neodymium-iron-boron (Nd-Fe-B) permanent-magnet material with a maximum stored magnetic energy [i.e., magnetic induction intensity or magnetic field strength] of over 47.0 megagauss-oersteds in all of the samples, with one sample reaching a value of 49.0 megagauss-oersteds. These values exceed that of 45 reached by several countries in Europe and America and come close to the value of 50.6 reached in a Japanese laboratory. The new value is an improvement over that of 45.7 megagauss-oersteds announced earlier this year (1 February) by the same group.

A panel of experts has inspected the materials and judged that they are ready for trial batch production. Permanent-magnet materials are used to generate magnetic energy when an external power supply is not available, and are widely applied in areas such as large-scale rockets, communications satellites, metallurgy, chemical engineering, medical treatment instruments, and the electronics industry.

Extraction and Purification of Bacillus Sphaericus Toxin Protein

40081033-P Beijing KEXUE TONGBAO in Chinese Vol 34 No 1 Jan 89 pp 61-64

[Article by Lin Guohua [0491 0948 5478], Wang Mingbo [3769 2494 3134], Fan Yunlin [5400 0061 0362] of the Molecular Biology Research Laboratory, Biotechnology Research Center, Chinese Academy of Agricultural Sciences]

[Summary] It has been proven that the toxicity and the fermentation potency of Bacillus sphaericus strain 10 H5a5b (BS-10 H5a5b) isolated in Jiangsu Province, China, are greater than those of BS 1593 isolated by Davidson in the West. A simpler method was designed to study, extract, and purify BS-10 pesticidal toxin protein in order to study the properties of the toxin, its molecular genetics and the technology to manipulate the toxin. The new method requires only a small amount of spores for the extraction of BS-10 toxin protein, the final yield being 13.5 mg per 5000 ml culture medium. Two primary protein bands 45 kD and 60 kD were obtained from SDS-polylene gel electrophoresis extraction. The researchers are now developing an antibody against the purified BS-10 toxin protein.

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Synthesis, Bacteriostatic Activity of 2-Furanthiocarboxyhydrazones, Their Transition Metal Complexes

40091029a Beijing YAOXUE XUEBAO [ACTA PHARMACEUTICA SINICA] in Chinese Vol 24 No 1, Jan 89 pp 27-31

[English abstract of article by Ge Weiying [5514 5588 4481] and Xu Lijun [1776 7787 0687] of the Department of Pharmacy, Shandong Medical University, Jinan]

[Text] In this paper, 9 compounds of 2-furanthiocarboxyhydrazones and 13 of their transition metal complexes have been synthesized and tested for bacteriostatic activity against several kinds of bacteria. The results show that all the compounds tested demonstrated antibacterial activity. The complexes of Cu(II), Ni(II) and Zn(II) ions display higher activity against gram-positive bacteria than do the 2-furanthiocarboxyhydrazones and the other complexes. The complex of the Ag(I) ion is more active against gram-negative bacteria when compared to 2-furanthiocarboxyhydrazones and the other complexes. The results are also in agreement with the earlier idea that the "NCS" group is the active site and that its activity has a certain relationship with its complexing ability.

Bacteriostatic Activity of 2-Furanthiocarboxyhydrazones and Their Transition Metal Complexes

Compd	Inhibition concentration(μg/ml)									
	M. tuberculosis	*B. subtilis*	*S. hemolysis*	*S. aureus*	*S. peneumoniae*	*B. pumilus*	*S. dysenteriae*	*P. aeruginosa*	*S. typhosa*	*E. coli*
1	0.1	0.5	1.9	3.3	20	35	50	28	40	45
2	1.56	3.12	50	25	25	3.12	25	40	60	50
10	3.12	100	100	100	100	50	50	50	100	60
11	12.5	25	50	6.25	12.5	3.12	50	50	100	55
12	12.5	6.25	50	25	50	3.12	50	50	100	55
13	12.5	50	100	100	100	50	50	50	100	60
14	0.78	3.12	12.5	0.78	25	3.12	25	45	50	50
15	0.25	0.39	3.12	1.56	6.25	3.12	50	45	100	60
16	1.56	3.12	50	12.5	25	3.12	12.5	28	50	50
17	0.78	1.56	50	100	12.5	6.25	0.39	5	0.39	3.12
21	0.01	0.05	0.39	0.28	5	0.3	12.5	50	50	50
22	0.1	0.32	0.39	3.5	15	2.6	25	40	40	50

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Immunological Study of Synthetic Peptide with HBsAg Activity

40091029b Beijing ZHONGHUA YIXUE ZAZHI [NATIONAL MEDICAL JOURNAL OF CHINA] in Chinese Vol 69 No 1, Jan 89 pp 28-30, 64

[English abstract of article by Luo Kangxian [7482 2123 0341], et al., of the Hepatitis Laboratory, Nanfang Hospital, First Military Medical College; Xu Laigen [1776 0171 2704], et al., of Shanghai Institute of Biochemistry, Chinese Academy of Sciences]

[Text] A cyclic 24-peptide covering 122-145 residues of the HBsAg sequence was synthesized. This study was intended to probe into the prospect of the peptide as a candidate for a hepatitis B vaccine. The results of radioimmunoassay showed positive reactions between anti-HBs and the synthetic peptide, as well as between the anti-peptide and HBsAg. Using GP28/P23, a major protein dissociated from HBsAg, as the antigen, the affinities of the anti-peptide and anti-HBs were determined and no significant differences were found. This indicates an excellent homology exists between them. Rabbits were immunized with the peptide, 300 μg x 3, and with the HB vaccine, 3 μg x 3, both of which had been added to Freund's adjuvant. The serologic anti-HBs level induced by the peptide was nearly 3.3 orders of two-fold dilution lower than that induced by the HB vaccine. When mice were immunized with alum adjuvant, 250 μg of peptide induced an anti-HBs response roughly equivalent to 0.25 μg of HB vaccine. Therefore, the immunogenicity of this peptide was approximately $(6\text{-}12) \times 10^{-4}$ times that of the HB vaccine.

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Effect of Various Purified HMGs on Transcription Activity

40091028a Beijing BEIJING DAXUE XUEBAO [ACTA SCIENTIARUM NATURALIUM UNIVERSITATIS PEKINENSIS] in Chinese Vol 25 No 2, Mar 89 pp 230-234

[English abstract of article by Zhou Xunlei [0719 6598 5628], et al., of the Department of Biology, Beijing University]

[Text] The functions of various single HMG [High Mobility Group Nonhistone Chromosomal Proteins] elements and their different compositions were measured by observing the effect of the HMGs on transcription activity with cell nuclei and the DNA of Beijing Duck polychromatic erythrocytes. The results indicated that the activities of the nuclei transcription in vitro were inhibited by the addition of HMG1 + HMG2a + HMG2b, but not by HMG1 or HMG2a or HMG2b additions alone. However, in the DNA transcription systems, the transcription activities could be inhibited by adding either HMG2a or HMG2b. Neither HMG14 nor HMG17 exerted any obvious effects on the transcription activities of either the nuclei or DNA systems. It should be emphasized, however, that the activity of nuclei transcription was promoted obviously through the addition of 20 μg of HMG14 + HMG17.

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Restriction Endonuclease Analysis of Mitochondrial DNA from Normal, Cytoplasmic Male-Sterile (CMS) Rice

40091028b Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY-NATURAL SCIENCE] in Chinese Vol 27 No 4, Dec 88 pp 367-373

[English abstract of article by Zhuo Degen [0587 1795 5327], et al., of the Institute of Genetics]

[Text] The rice mitochondrial DNAs (mt-DNAs) were prepared from members of N (fertile), cms-WA, cms-BT and cms-RL groups. Restriction endonucleases Pst I, Hind III and Xho I were used to digest the mt-DNAs, and the resulting fragments were examined through gel electrophoresis and compared. The results showed that they were each quite distinct and that the mitochondrial DNAs from the normal Zhenxian 97 B and Nonghu 26 B were different. The estimated minimum molecular sizes of rice mt-DNAs ranged from 195 to about 245 kb.

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Purification, Characterization of Glutamate Dehydrogenase from Brevibacterium Flavum

40091028c Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY-NATURAL SCIENCE] in Chinese Vol 27 No 4, Dec 88 pp 395-401

[English abstract of article by Lu Weiping [7120 5898 1627], et al., of the Department of Microbiology and Microbial Technology]

[Text] Glutamate dehydrogenase was purified 230-fold from Brevibacterium flavum by ammonium sulphate fractionation and chromatographies on DEAE-cellulose, Phenyl-Sepharose CL-4B and Sephadex G-200. The enzyme had a molecular weight of about 300,000, and consisted of six subunits, each with a molecular weight of 50,000. It exhibited a single band after electrophoresis on SDS-polyacrylamide gel, and K_m of 0.294 mol/L and 0.1 mmol/L for glutamate and $NADP^+$, respectively. It had a pH optimum around 8.9 and demonstrated medium thermo-stability.

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Isolation of Tn21 Inserted Plasmid, Construction of Recombination Plasmids with Streptomycin Resistance Gene

40091028d Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY-NATURAL SCIENCE] in Chinese Vol 27 No 4, Dec 88 pp 458-464

[English abstract of article by Zheng Zhaoxin [6774 0340 9515], et al., of the Institute of Genetics]

[Text] A recombinant plasmid pXZ2712 was isolated from *E. coli* Lc2640, which also carried the plasmids R100.1 and pSC101. The plasmid pXZ2712 conferred resistance to streptomycin, mercuric chloride, sulfonamide and tetracycline. Remarkable homology was observed by the hybridization between the plasmids pXZ2712 and pXZ2, the latter of which carries within it two Tn21 termini. It was inferred that pXZ2712 was formed by the insertion of Tn21 into the plasmid pSC101. A fragment was also isolated which conferred streptomycin resistance and constructed several recombinant plasmids, pXZ6 (14.7 kb), pYP1 (9.7 kb), pYP22 (9.1 kb), and pYP4 (4.0 kb), all of which conferred streptomycin resistance.

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Major Achievements In Microbial Fermentation and Gene Engineering Research

40081032 Beijing BEIJING KEJIBAO [BEIJING SCIENCE AND TECHNOLOGY NEWS] in Chinese 15 Mar 89 p 3

[Excerpts] The Chinese have reported these major achievements in Microbial Fermentation and Gene Engineering Research for 1988:

(1) The new microbial fermentation technology developed to produce SOD (superoxide dismutase) by Beijing Polytechnical College. SOD is a pharmaceutical enzyme applied clinically in radiation protection; cancer and senility prevention; hypertension and coronary disease control; and rheumatoid arthritis and cholecystopathy (gall bladder disease) treatment.

(2) Success in synthesizing glutamic acid-cysteine-glycine peptide (tripeptide) from candida strain K11 obtained from among 3,041 strains of common yeast by the Shaanxi Provincial Microbiology Institute. The tripeptide is clinically important in treating liver disease, drug intoxication, poisoning during pregnancy, heavy metal poisoning, cataract, skin disease and cancer. The new mutant strain K11 UE 126 derived from uv irradiation can yield 2,47 percent dry weight of tripeptide compared with 1.8 percent of the original strain K11, a 49.7 percent increase.

(3) A high-yield bacterial strain producing acylase for making penicillin and cephalomycin was obtained by the Microbiology Institute of the Chinese Academy of Sciences. The pure product of acylase has molecular weight of 14,300 and 58,900, and has 400-500 unit/100 ml normal enzyme activity which is recently elevated to 600 unit/100 ml. The product is now being tested by the pharmaceutical company and will be put on the market soon.

(4) Maize gibberol-producing bacteria was obtained by the Beijing Institute of Nutrient Resources. Gibberol, a livestock growth hormone with a low toxicity to animals, can increase the weight of cattle by 21.77 percent, and that of sheep by 26.65 percent. It is now in large-scale production.

(5) Rabbit hemorrhagic disease virus vaccine was developed by the Wuhan Institute of Virology of the Chinese Academy of Sciences. The vaccine's protection rate is as high as 90 percent.

(6) Human alpha-1 gene engineered interferon (IFN) and HBsAg gene engineered vaccine were developed by the Institute of Virology of the Chinese Academy of Preventive Medicine and are now in the stage of clinical tests. The yield of the engineered bacteria producing IFN is 70-119 g/l. The IFN expression rate is 5-13 X 10^7 IU/l, and its recovery rate is 40-50 percent. The interferon is clinically used in treating phase 1 and phase 2 viral keratitis and cervical erosion, and it is expected to be marketed in 1989. The jointly developed HBsAg gene engineered vaccine by the institute and the Biochemistry Institute of the Academy of Sciences is now in stage 1 clinical tests.

(7) Gene engineered-microbe synthesized growth hormone and penicillin fermentation acylase developed by the Shanghai Institute of Cell Biology and the Institute of Pharmaceuticals of the Chinese Academy of Sciences are being testing and are expected to be commercialized.

(8) A viral infection-resistant engineered tobacco plant was produced by the Microbiology Institute of the Chinese Academy of Sciences. The plants regenerated from tobacco cells were obtained by transforming the cells by introducing the intact DNA from Chinese synthesized cucumber mosaic virus (CMV) satellite nucleic acid and tobacco mosaic virus (TMV) coat protein gene through Ti plasmid transformation; 112 plants of this kind have been regenerated.

(9) Regeneration of pest-resistant rice plants from protoplasts was achieved by the Research Center of Biological Technology of the Chinese Academy of Agricultural Sciences by transferring the pesticidal toxin gene from Bacillus thuringiensis to the protoplasts of rice plants from which a new plant was produced. The experiments being conducted by the research team involve the regeneration of a new rape plant by introducing the pesticidal toxin gene into the rape protoplast through a recombinant plasmid (pGY61).

(10) A herbicide-resistant engineered soybean plant was produced by the Genetics Institute of the Chinese Academy of Sciences by introducing trinitrophenyl herbcide (Atrazine psbA)-resistant gene from nightshade into chlorophyll genome of a soybean plant to generate a new herbicide-resistant soybean plant.

Dynamic Response of Blood Flux of Various Organs of Rabbits Under Simulated Weightlessness

40091030 Beijing KONGJIAN KEXUE XUEBAO [CHINESE JOURNAL OF SPACE SCIENCE] in Chinese Vol 9 No 2, Apr 89 pp 148-154

[English abstract of article by Xiang Qiulu [0686 3061 7627], et al., of the Institute of Space Medico-Engineering, Beijing]

[Text] In this paper, a zoological model experiment using 26 rabbits is reported and the dynamic response curves of the blood flux of various organs are given. The relationships between the blood flux and the functional state of the microvessels of various organs under simulated weightlessness conditions are also analyzed using the microcirculation method. Finally, the characteristics of the changes of the microcirculatory functions of various organs are described, and the mechanisms of these changes are discussed.

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Series of Array Processors Debuts

40080149a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 8, 1 Mar 89 p 15

[Article by Feng Shude [7458 2885 1795], North China Institute of Computing Technology: "NCI AP2900-Series Array Processors"; see also JPRS-CST-88-012, 12 Jul 88 p 70]

[Text] After the North China Institute of Computing Technology AP2701 high-performance floating-point array processor passed its technical evaluation in September 1985, that institute produced two new models in 1986, the AP2704 and the AP2801. These devices are currently being used in dozens of departments.

With the support and guidance of the Computer Office of the former Ministry of Electronics Industry, in 1986 it was decided to bring out an AP2701 gate-array series, to improve its performance indicators, and fit it to an AP2901 device, all as a development plan for the first fourth-generation computer.

This plan was divided into two phases. The first phase called for developing 14 different CMOS [complementary metal oxide semiconductor] 3,000-gate gate-array chips for the AP2901 in 1987; the second phase, to take place in 1988, called for development of seven different CMOS 3,000-gate gate-array chips and four kinds of 6 000-gate gate-array chips. The first phase of the plan had been completed by the end of 1987 by which time ten kinds of chips had replaced logic components in the original machine, and at the same time memory chips of an even greater degree of integration had been fitted to the AP2901 array processor. Second phase designs have entered their later stages. It is estimated that in 1989 this will all be assembled into China's first all-CMOS gate-array fourth-generation computer, the AP2901C.

Primary characteristics of the AP2900 series:

1. It has multi-functional components, multiple data paths, and multiple bus parallelism. Pipelined operation allows for an improvement in calculation speed.

2. Its flexible data format conversion and interfacing techniques allow this device to be connected to various different machines.

3. The primary components have been designed as 2.5-micron CMOS gate-array devices, which has lowered overall power consumption, reduced the size, and improved its anti-interference capability.

4. Excellent diagnostics and error-checking software aid in maintenance.

5. There is abundant software support and a user-programmable capability.

6. There is a high performance-to-cost ratio.

Primary technical specifications:

1. Master clock frequency: 6 MHz

2. Data format: floating point with 10-place characteristic and 28-place mantissa, and a solution range from 3.9×10^{-153} to 6.5×10^{153}.

3. Length of instruction word: 64 bits, and ten operations can execute concurrently.

4. Pipelined operations: second-order floating-point addition pipelining with a maximum calculation rate of 6 MFLOPS [million floating-point operations per second]. Third-order multiplication pipelining, with maximum processing speed of 6 MFLOPS.

5. Storage system configuration:

Name	Capacity	Operating Cycle
Instruction memory	8K 64-bit words or	167 ns [nanoseconds]
	32K 64-bit words	167 ns
Data memory	256K 38-bit words or	167 ns or 330 ns
	1,024K 38-bit words	167 ns or 330 ns
List storage	4.5K 38-bit words (ROM)	167 ns
	8K 38-bit words (RAM)	167 ns
Data buffer	two x 32 38-bit words each	R/W 167 ns

Software support

The primary software for the AP2900-series machines includes:

1. A management programming software package (APEX): connects generation of the host operating system, manages AP [array processor] internal resources, and controls the execution process of AP with host communications.

2. Math library (APMATH): includes basic math libraries, high-level math libraries, image-processing libraries, signal-processing libraries, seismic data processing libraries, and libraries of applications routines that may be called by a user.

3. Development programming package (APPDS): includes assembly language and APFORTRAN, as well as a compiler, linker, loader, simulator, debugger, library editor, and vector function linker.

4. Testing and diagnostic software: includes AP Test, APPATH, APARTH, and APMEM. These programs can fully test and check the various functional components, data paths, storage, and interfaces throughout a machine, and can locate erroneous entries. It also produces accurate and real-time values for use by maintenance personnel for analysis and location of faults.

Applications

This computer can be connected to various mid-size and minicomputers to create data processing systems of different types, which enables their processing capabilities to near those of mainframes or supercomputers. For connection, a single cable is simply inserted directly into a bus slot on the host machine. The application fields for this computer include seismic-prospecting data processing, remote-sensing image processing, digital signal processing, analog simulation, CT diagnosis, radar, and missile guidance.

At present, there are two computers, the AP2901 and the AP2904, in the AP2900 series. The AP2901 can be used with all single-bus computers, as for example the VAX 11/780 and 750, and the PDP-11/24. It can also be connected with such Q-bus computers as the PDP-11/23, the MicroVAX II, and the Taiji 2220. The AP2704 can be connected to all classes of the PE3200 series. During actual use, its use will generally improve the calculation speed of the host processor by from several to more than a hundred times.

Prospects

Gate-array technology is a circuit technology that is required for development of fourth-generation computers. The CMOS gate-array chips we have used are only the beginning. There is still much we want to do. But the development and application of this technology is sure to stimulate the overall growth of China's integrated-circuit manufacturing techniques and technology, printed-circuit-board manufacturing technology, and interconnection technology.

Status, Future of Domestic Chinese-Character Information Processing Technology

40080149b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 10, 15 Mar 89 pp 50, 52

[Article by Liu Weichang [2692 4850 7022], Beijing Municipality Institute of Computer Technology: "Aspects of Growth in China's Chinese-Character Information Processing Technology, and Its Future Tasks"]

[Text] In recent years, China's Chinese-character information processing technology has made remarkable gains in the areas of research and applications. General-purpose Chinese-character processing systems have achieved widespread use in all sectors of the national economy. Specialized Chinese-character systems, as for example laser phototypesetting systems and Chinese-language typewriters, have also entered the stage of application. From the point of view of levels of technology, the domestically developed Chinese-character information processing systems are in no way inferior to similar systems developing in Japan, Singapore, and the United States. But new problems have arisen during actual use that have yet to be solved. Some of these problems are technical, and some will need correct policies for resolution.

I. The Level of Basic Technology

1. Technology that is compatible with both Chinese characters and Western languages

The general-purpose Chinese-character systems developed in China all use technologies compatible with both Chinese characters and Western languages. In other words, the technology used by China is to add Chinese-character capability to existing computers, which on the basis of preserving all original functions for the processing of Western text, allows for the ability to similarly process Chinese characters. By adopting this technology we can fully utilize the resources of existing computers, by which we can not only greatly reduce development time, but

can also enable the growth of China's Chinese-character information processing systems to develop in step with international computer systems.

Common methods for the implementation of Chinese-character compatibility with Western text include three methods: software, firmware, and hardware. The majority of microcomputer systems commonly use software methods; that is, they expand the portion of routines in an operating system that manage peripherals, which then enables them to support Chinese-character processing. This was the earliest used method, and it has been widely applied. What we mean by the firmware method is where those expanded portions of the operating system are burned into EPROMs [erasable programmable read-only memories] on a Chinese-character card, which can allow a majority of software that could formerly only handle Western text to directly deal with Chinese characters in situations where the operating system is not modified. Multi-user supermicros, as well as other minicomputer and mainframe systems, all use hardware methods to bring in Chinese characters, namely by using Chinese-character terminals. There are more than ten factories in China that can manufacture Chinese-character terminals, but each terminal is restricted to certain computer models.

These three Chinese-character techniques are all reasonably established in China, and a majority of computer systems can achieve the desired Chinese-character results.

2. Chinese-character keying techniques

Entering Chinese characters from a standard keyboard is the most common way to enter characters in current Chinese-character information processing systems. The long-standing problems here have seen some real advances. Experts have realized that by calling upon the intelligence of the computer to increase the keying process, they can lighten the mental burden of the operator.

There are at present no fewer than 500 different Chinese-character input methods, among which about 50 are being used in various Chinese-character information processing systems, and about a dozen are more common. Each input method has its strengths and each has its shortcomings. Some are suited to the average operator, while some are more suited to trained operators. In view of these facts, current Chinese-character information processing systems usually come with several different input methods, from which different users may choose.

Classifying according to input techniques, input methods may be divided into three major classifications: whole character character element, and character code. Whole-character keying through a large keyboard is hardly ever used in general-purpose Chinese-character systems, being used exclusively in special systems. Character-element keying and code

keying using the standard small keyboard are more common. By character-element input is meant the inscribing of character elements (from some tens to more than 100) on key caps, then after analysis of the Chinese character, keys are pressed in the normal keystroke order. This method is rather easier to learn and is suitable for the average operator. Coded input involves the conversion of such characteristics of Chinese character as sound or shape into ASCII [American Standard Code for Information Interchange] symbols, which are then used to enter those characters via a standard keyboard. Generally speaking, this latter method requires more time to learn, but if the coding is appropriate a higher rate of input can be achieved after training, and this is suitable for professionals.

Phrase input has also been applied in some Chinese-character information processing systems, and at present the two most common methods are based on sound and character elements, respectively. For the former system, one need only sequentially enter the first spelled syllable for each Chinese character in the phrase, and for the latter, one need only enter the first character element for each Chinese character. The computer can then automatically convert this into the corresponding phrase. After a certain amount of training, use of this method greatly improves the Chinese character entry rate.

With a certain amount of training, the average operator using the common Chinese character input methods can enter 20-40 characters per minute. By using phrase input, this can exceed 100 Chinese characters per minute.

3. Chinese-character automatic recognition techniques

Research efforts in China on Chinese-character automation recognition began at the end of the 1970s. Contemporary Chinese-character recognition techniques of printed fonts and on-line hand-written characters have begun to emerge from the laboratory into practical use. Theoretical research into recognition of non-machine drawn forms has made certain advances.

The theoretical basis for the recognition of Chinese characters is an extraction from the characteristics of Chinese characters. These efforts have produced pleasing results and have departed from the limitations of early Japanese work to gradually constitute a method markedly Chinese. Of the characteristic extraction methods currently proposed, some use the features of 3- and 4-corners of Chinese characters; some extract the length of the circumference; some use features of partial structures; and some choose transverse structural segments of characteristic points or groups of characteristic points. These methods all not only see Chinese character as purely 2-dimensional images, but also see them as specific images having Chinese-character structural characteristics.

Significant breakthroughs have been made in research efforts on recognition of printed characters, and at present there are at least six systems that have passed their evaluations. The majority of these systems have been built on microcomputer foundations, and for this reason they are far from ideal in performance. These systems all input Chinese characters using scanning devices and can generally recognize Song-font or pseudo-Song-font Chinese characters, and some can even read boldface fonts; character sizes range from one to five; some can recognize the first level of 3,755 common Chinese characters, while some are able to recognize 6,763 common characters of the first and second levels; the recognition percentage is about 95-99 percent; and the rate of recognition is 1-10 characters per second [see JPRS-CST-88-012, 12 Jul 88 p 67, and JPRS-CST-88-020, 28 Sep 88 p 42]. When compared with those of foreign technologies, these specifications are still far behind.

Good results have also been achieved in the area of the recognition of on-line hand-written characters. Some current implementations have been made into commercial products and can be used on micros. The majority of these devices can recognize the 6,763 common characters, and the recognition percentage--90 percent and more--is determined through standard routines for inputting Chinese characters [see JPRS-CST-88-016, 29 Aug 88 pp 52-53]. Current systems are quite limited in regard to hand-written characters, and the rate of input is far from that of keyboard input, as there are still technical problems that must be resolved in their dissemination and application.

The degree of difficulty for off-line hand-written Chinese characters is quite high, and there has been no substantive progress as yet. It still has a very great distance to go before actual use.

4. The technology of the recognition of Chinese phonetics

Recognition of Chinese phonetics involves linguistics, phonics, and artificial intelligence, and it is work with a high degree of difficulty. China is currently still at an experimental stage.

We can see from research efforts in phonetics recognition that the majority of work in China uses the already existing American TI [Texas Instruments] phonetic system, from which basis secondary development is being done to implement Chinese language phonetics recognition on microcomputers [see JPRS-CST-88-015, 12 Aug 88 p 51, and JPRS-CST-89-004, 2 Feb 89 p 49]. But some scientific research departments are using A/D [analog to digital] and D/A for research from an entirely different perspective.

Some Chinese phonetic recognition systems that have been developed are stalled at the level that inputs interrupted speech manually. In other words, before new operators can use a system, they must train that

system before entering sounds, and what is more, the speech must be cut off, as it is not permissible for it to go on past a certain point. Some better systems can recognize several thousand words, but the rate of recognition is usually related to the operator, when it can be generally 90 percent and greater.

The United States is planning to finish a system by 1992 that can recognize 20,000 words, is not manual, and into which continuous speech can be input. In comparison with that, China will need to do a great deal more work in the area of Chinese-language phonetic recognition technologies before it can catch up with the advanced international level.

5. Chinese-character compression techniques

Chinese-character compression is a technique for building highly information-dense Chinese-character libraries. The basis of this concept is that the matrix for each Chinese character in a character base will be replaced by a characteristic code that is shorter than normal, which will reach the goal of data compression. When these Chinese characters are output, this characteristic code will be restored to the original Chinese character matrix using a predetermined algorithm.

In earlier Chinese-character data processing systems, a compressed character library of a single font was invariably used because of limited storage capacity, and the techniques used included black and white segmentation, unequal length coding, character-element synthesis, and vectorization. With the increase in microcomputer storage capacities, Chinese-character compression techniques are now seldom used in general-purpose Chinese-character data processing systems.

Chinese-character compression techniques are currently more often used in phototypesetting systems, light-duty printing systems, or in laser phototypesetting systems. These systems are required to generate Chinese characters of various sizes and of various fonts, and if compression techniques are not used, system storage capacities are bound to be quite large. There are many ways to build multi-font compressed character bases. The basic idea behind these is: build a skeletal Chinese character library, then use software to generate the various different kinds of Chinese characters. Implementing this character base on a microcomputer would require only a few hundred kilobytes [of memory]. Using Chinese-character compression techniques in a precision phototypesetting system, data compression can reach 10^3 and higher. Use of these techniques can generally result in high-quality Chinese-character output.

6. Chinese-character output techniques

At present, there are primarily two kinds of output equipment for Chinese-character data processing systems: printers and display devices.

Printers are most often of the dot-matrix variety, and current Chinese production of such printers is growing from a single model toward a series of products. The speed of these printers is generally 40-100 Chinese characters per second, the shape of the characters is variable, and some even come with Chinese-character character libraries.

Laser printers have begun to be used in domestic Chinese-character processing systems, but because interfacing techniques are not yet perfect, laser printer functions have yet to be fully utilized. The nominal speed of the low-grade laser printers used in microcomputer Chinese-character processing systems is eight pages per minute, but the actual speeds are invariably no greater than two pages, and this problem has not yet been resolved.

CRT screen resolution is generally 640 X 400 or 640 X 480, fonts are usually 16 X 16 matrices, but there are also 24 X 24 and 32 X 32 ones. Display formats have been gradually unifying, and are generally 25 lines, with each line having 40 characters. This type of display is in the process of becoming Chinese-produced.

LCD displays are at present used only in portable Chinese-character systems.

7. Methods of machine code notation

The selection of appropriate machine code, that is, the coding of Chinese characters in the computer ("internal code" for short), is a key problem for designing Chinese character systems that are compatible with Western languages. There is a great deal of controversy in academic circles regarding this problem, and there is as yet no unanimous view. For these reasons, different Chinese-character systems will invariably use different codes. Among the internal codes often seen today in China are:

a. 2-byte expressions: set to 1 the highest bit position of one or both bytes of 2-byte Chinese-character exchange codes in order to distinguish them from ASCII codes.

b. Graphic character recognition: treat an unused graphics symbol as a Chinese-character signifier, some systems using this signifier as the beginning and end of a Chinese character string.

c. 3-byte expressions: three bytes are used to represent a Chinese character. Commonly used systems include "AAD" (where 'A' represents

the 26 letters from A through Z, and 'D' represents the ten digits from 1 through 9) and "AaA" (where 'A' represents the 26 uppercase letters and 'a' the 26 lowercase letters).

Generally speaking, the 2-byte representation method has the least data redundancy, which aids in the conversion to exchange codes, but the 3-byte expression method is more competible with Western languages.

II. Existing Problems and Their Solutions

There are currently tens of thousands of Chinese-character data processing systems being used in China in such sectors as national defense, research, teaching, industry and commerce, and banking, among which the great majority are running on microcomputers. From the point of view of data processing, this activity includes the following fields of application:

-- office automation;
-- Chinese medicine expert systems;
-- laser phototypesetting;
-- television subtitle creation systems;
-- large-screen display.

As far as actual applications are concerned, there are still many problems for Chinese-character data processing technology in China. Briefly, there are the following aspects.

1. Chinese-character key input methods need to be optimized.

Practice over the years has shown that because of the uniqueness of Chinese characters, there is no hope that there will ever be a standard method of entering Chinese characters. For professional entry personnel, speed is utmost; for the general user, ease of learning is naturally of prime importance. These two specifications will always be in contradiction. Therefore, a general-purpose Chinese-character system, even those of the future, should come with one of the keying methods just mentioned.

A more ideal general-purpose Chinese-character data processing system should include one or two optimized keying methods that are suitable for professionals, as well as one or two keying methods that are appropriate for the average user. Because Chinese characters are ideographic, these methods should focus on the "putting together of pieces," with "spelling" as a supplement. Various keying methods should utilize the techniques of artificial intelligence to the greatest possible extent to improve the rate of keying and to lighten the burden of the operators.

2. The internal coding of Chinese characters must become more standardized.

The internal coding of Chinese characters in current Chinese-character systems is not uniform, which makes computer networking efforts very difficult, and to a great degree restricts the exchange of software and the further dissemination and application of Chinese-character processing systems.

The only solution to this problem is standardization.

Years of practice have shown that the situation is similar to that of the keying method, that is, that to hope that all Chinese-character systems throughout China will use a standard internal coding for Chinese characters would appear to be unrealistic. This is because internal coding is designed to bring in Chinese-character processing, and since the objectives thereof differ and working environments are not the same, the internal coding that is used will differ. Even so, it is still possible to formulate a small number of standard codes. To optimize the internal coding of Chinese characters, we must similarly research and formulate scientific standards of evaluation.

3. We urgently need to build common glossaries.

It is common knowledge that phrase input is an effective way of improving the rate of Chinese-character keying. Even so, there is not currently in China a common collection of Chinese language phrases comparable to the first and second levels of common Chinese characters. For this reason, a basic step that urgently needs taking for Chinese-character data processing technology is the intensification of research on Chinese word and phrase attributes by which to build a common library of Chinese phrases for use by Chinese-character data processing systems.

In addition to the building of such a linguistically oriented glossary, another problem worth exploring is how to physically compress that library of phrases. To enable Chinese-character data processing systems to play even greater roles in the various professional areas, in addition to studying general-purpose common phrase glossaries, it is also necessary to research specialized common-phrase collections for specialty fields.

4. The tools for introducing Chinese characters to computer use must be improved.

To being Chinese characters into computer systems that could originally only handle Western language data is a very complex and time-consuming effort, an effort in which China formerly used only manual methods. In recent years, some researchers have begun to notice how to use new tools to improve the working environment, and this is quite worthy of attention. To a certain degree, use of computer-aided design to solve

various keying optimization problems has been successful, but what needs further work is the design of particular software tools that can do real-time evaluation of various keying methods, and this is also something that needs research.

Software tool programs for integrating Chinese characters have been developed for microcomputers, changing the manual single-step operation into a program automated "batch entry," which integrates Chinese characters using techniques derived from successful efforts with the dBASE III and ORACLE relational databases.

It would be very significant to develop software tools that can automatically parse Chinese-language phrasing.

5. Research efforts in large-capacity, multiple-font Chinese-character libraries needs to catch up.

The interfaces between light-duty printing systems and Chinese-character laser printers all need multiple-font Chinese-character libraries with capacities of 10,000 and more Chinese characters; these must generate Chinese characters of different qualities. Because the internal storage capacities of these devices cannot be made too great due to current physical limitations, effective compression techniques must be used for these Chinese-character libraries.

Domestic Chinese research at present on this work has not produced much, and although some results are being used in real systems, they are imperfect. Techniques that result in high compression of data are invariably harmful to character quality, or the decompression time is too long, all of which limits applications.

After these character libraries have been optimized, they can be burned into standard LSI [large-scale integration] circuitry, and this will undoubtedly generate a major stimulus for the growth of contemporary Chinese-character data technologies. Those sectors concerned with this problem should fund and organize manpower to attack this fundamental research problem.

6. The pace of development for specialized Chinese-character systems must be stepped up.

More than 150 different Chinese-character systems have been developed in China thusfar, but nearly all are general purpose, and these systems sometimes have insufficient functions for certain application environments, while at times their great capacities are underused. Therefore, it is an urgent matter to develop specialized Chinese-character systems for the different professions.

What first needs faster development and expanded production are portable Chinese character printers. Ancient mechanical printers are clearly not

up to the demands of the current information age, and it has become essential to replace traditional printers with word processors.

At present, China still lacks suitable Chinese-character printers, especially the portable kind. Some units use general-purpose Chinese-character systems for word processing, but this is overkill, and to some extent even limits the application environment.

Research on pocket-size electronic notebooks should be placed on our agenda. These electronic notebooks can be used for making notes, can store large amounts of Chinese-character data, and have a great deal of potential. Naturally, development of this effort is closely tied to development of LSI.

China still lacks vending machines with Chinese-character capabilities, and to a great degree this has obstructed the application of computers in commercial systems. The machines of this sort that we do have in relevant applications systems are modifications of imported vending machines, and some are definitely not appropriate for the situation in China. The degree of difficulty for this technology is not too great, and it would be easy to accomplish with attention from relevant sectors.

Industrial controllers with Chinese-character dialogue interfaces are also missing at present in China. Bringing Chinese-character processing technologies into industrial controllers would greatly improve system friendliness, would increase the transparency of control systems, and would decrease human error. In addition, the pace of development for such specialized systems as electronic advertising and electronic displays has not kept up with demand.

Beijing Aerospace University Develops World-Class Optical Disk

40080163a Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 12, 29 Mar 89 p 1

[Summary] Scientists at the Noncrystalline Physics Laboratory of Beijing Aerospace University have developed an optical disk which meets international standards. Four 8-inch optical disks have demonstrated a reflection contrast greater than 30 percent, a carrier-to-noise ratio of 50dB, and an erase-write cycle index [ca xie xunhuan cishu] exceeding one million times.

Using imported technology, the research group began its effort in 1985, and by 1987 had produced a batch of prototype disks. By last year, the erase-write cycle index had broken through the 100,000 barrier. The researchers plan to set up a test production facility soon, and to have a plant for commercial production set up by 1991.

New Plotting Software for Nuclear Industry

40080163b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 12, 29 Mar 89 p 18

[Summary] To promote applications of computer graphics and computer aided design, the Shanghai Nuclear Engineering Research & Design Institute has developed plotting software for generating graphical data files. This software has been successfully tested in such tasks as designing nuclear power plant terminal lines, drawing cross-sectional diagrams for laying cable, designing charts of connections on the rear faces of the instrument panels in the main control room, and studying the control principles in electrically operated valves. This software is designed for an IBM-PC/XT microcomputer, a low-resolution monitor, and a DMF-42 plotter, and has been developed with the aid of Auto-CAD version 2.17 software. Data is entered and designs refined via man-machine dialog.

National Defense University of Science & Technology Develops Military Expert System

40080163c Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 14, 12 Apr 89 p 1

[Article by Sang Ye [2718 0673]]

[Summary] A multifunctional military expert system developed by the National Defense University of Science & Technology recently passed technical accreditation. This system can be used in tactical training, as an aid to troop inspectors in assessing the degree of correctness in decisions made by command personnel, and directly by command personnel as a battlefield or field-exercise aid to decision-making.

The system, which uses C language, runs on an IBM-PC/AT microcomputer, and consists of a global data base, a knowledge base, an inference engine, a basic data base, an interpreter subsystem, and a man-machine interface. The inference engine incorporates fuzzy inferential methods, with two kinds of knowledge representation and three kinds (forward, backward, and hybrid) of inferential reasoning strategies. This is the first [Chinese] military expert system suitable for military personnel which has a three-level interpreter for inferential arguments [liyou]; such a system can handle military commands given in fuzzy natural language (Chinese).

Plant 262 Develops Microcomputerized System for Nuclear Radiation Monitoring

40080163d Beijing ZHONGGUO DIANZI BAO in Chinese 14 Apr 89 p 1

[Article by Wang Bin [3769 2430]]

[Summary] The microcomputer radiation-monitoring system developed by the Ministry of Nuclear Industry's Xi'an Plant 262 for nuclear power engineering was recently certified in Xi'an. All of the system's main technical indicators meet international standards of the early eighties. When it detects a problem, the system generates an alarm signal at the nuclear power plant's main control panel. The system is resistant to vibration and to electrical and weather interference, and has demonstrated a reliability of up to 100 percent.

New Interface Developed for Galaxy Supercomputer Emulator

40080177 Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 16, 26 Apr 89 p 1

[Article by Sang Ye [2718 0673]: "YH-Fl D/D Interface Developed for Galaxy [Super]Computer Emulator"]

[Text] In order to raise the level of applications of the Galaxy all-digital emulator YH-Fl and to increase the emulator's capability for digital communications, the University of Science & Technology for National Defense recently developed a D/D [digital-to-digital] interface for the Galaxy emulator YH-Fl. The interface has passed its technical appraisal in Shanghai.

The D/D interface for the Galaxy emulator employs the technologically advanced dual-port memory method, eliminating accessing conflicts, queueing, and waiting; this permits a data transmission rate as high as 20Mb/s between the emulator and the D/D interface. The software for the interface driver is written in assembly language, cutting down on time expenditure and allowing a transmission speed of three to six times that of [i.e., an increase of 200 to 500 percent over that of] the present interface driver. The YH-Fl D/D interface can be widely applied to semi-objective [ban shiwu] emulation systems and any other systems requiring the YH-Fl D/D interface. When used for semi-objective emulation systems, it can within one frame continuously transmit many [blocks of] data. Application and testing have demonstrated stable and reliable system operation; the transmission rate meets requirements and flexible diagnostic and test routines have been perfected. Experts at the accreditation felt that the YH-Fl D/D interface has broad prospects for application and have recommended that it be popularized.

FRG To Help Produce Oceanic Technology

40101018 Beijing CEI Database in English 5 Apr 89

[Text] Shanghai (CEI)--China and Federal Germany have decided to conduct a long-term cooperation in developing oceanic technology.

The cooperation concentrates on underwater tapping of petroleum and natural gas, underwater robots, and diving under high pressure.

Participants of the technological cooperation are 20 German universities, research institutes and enterprises and 15 Chinese governmental departments and organizations including National Bureau of Oceanography, State Commission of Science and Technology and the Chinese Academy of Sciences.

The cooperation in the four items are said to be part of a 1987-97 program of cooperation in oceanic science and technology between the two countries.

Experimental Study of THG of Ultrashort Laser Pulses

40090047a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 3, 20 Mar 89 pp 129-134

[Article by Xu Weiming [6079 0251 3046], Li Yongchun [2621 3057 2504], He Huijuan [0149 1979 1227], and Gu Shengru [7357 5110 1172] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] With a KDP(II)/KDP(II) cross polarizer, the authors conducted triple frequency experiments with a ps Nd:YAG mode locking laser; the energy conversion efficiency was as high as 52 percent. By simulating the calculation theory of experimental conditions, efficiency curves coincide closely with the experimental results.

An ultrashort-pulse laser with pulse duration of tens of picoseconds can be realized. Based on triple frequency high gain (THG), the 0.3547 micrometer wavelength laser is a light source of high intensity ultraviolet rays (relatively easily realized at present), which have very important functions in the fields of laser spectrum, plasma physics, biology and tunable lasers.

Twelve figures show theoretical curves indicating triple frequency efficiency of plane wave, a II/II type cross polarizer, triple frequency theoretical efficiency curves of plane waves in a II/II type cross polarizer with incidence at different polarization angles, variation curves of triple frequency efficiency in three settings, the experimental arrangement, comparison of experimental results in four settings, and a streak camera record of pulse waveforms. Four tables list parameters of the KDP(II) crystal and laser output, parameters of crystal adjustment frame, and transmissivities of the crystal surface and its window opening.

The authors are grateful to Dong Jingyuan [5576 2529 0337] and Lu Yutian [7120 7183 3944] for assistance in pulse measurements; to Qian Linxing [6929 2651 5281] and Zhao Longxing [6392 7127 5281] for assistance with laser power source. The paper was received for publication on 24 August 1987.

Signal-to-Noise Ratio Improvement for High Power Laser Systems by Photoelectronic Switching Technique

40090047b Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 3, 20 Mar 89 pp 135-137

[Article by Zhi Tingting [2388 1250 1250], Chen Lanrong [7115 5695 2837], Yu Wenyan [0151 2429 3508], Cao Weilou [2580 3262 2869], Liu Fongqiao [0491 7685 5062], and Wu Pengchun [0702 5570 2504] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] In the paper, the pulse voltage of a single pulse switch was selected as bias voltage of photoelectric conductance; the high voltage output pulse is as high as 10 kilovolts with satisfactory repeatability and reemergence. The measured efficiency of the silicon photoelectric conductance switch was higher than 95 percent. The trigger energy is less than 10 microjoules, and the rise time is in the picosecond range. Driven by a laser, the semiconductor photoelectric conductance effect can realize high precision synchronization between a photoelectronic switch and laser pulses, thus considerably raising the signal-to-noise ratio. The article reports the operational properties of this switch, and the experimental results by using this switch in a large neodymium-doped glass high power laser system.

Seven figures show a synchronization experiment arrangement, another experiment arrangement for raising the signal-to-noise ratio of the laser system, electric output pulses in three settings, measurement of fast rise time of auxiliary switch in Kerr cell, a ps mode locking laser system, and an ns laser system.

The authors are grateful to Fan Tianyuan [5400 3329 0337] and Xie Ziming [6200 2737 6900] for their assistance with high power laser system arrangement. The article was received for publication on 16 September 1987.

Investigation on Fluctuation Pulse and the Second Threshold of Passive Mode Locking

40090047c Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 3, 20 Mar 89 pp 141-147

[Article by You Nanchang [1429 0589 2490], Chen Shaohe [7115 4801 0735], He Weiming [0149 0251 2494], Yu Wenyan [0151 2429 3508], and Deng Ximing [6772 6932 6900] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences; and Song Guichai [1345 6311 2088] of Department of Physical Optics, Changchun Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] The article presents the buildup process of a calculated, simulated passive mode locking fluctuation pulse packet, and studies the effect on fluctuation pulse count, pulse width and second threshold caused by the laser beam cross-sectional ratio of gain medium and dyestuff on laser cavity length, linear attenuation, dye concentration, and pumping rate. In the experiments, it was determined that there is better matching with the measured fluctuation pulse count and the second threshold, on the one hand, and the theoretically indicated values, on the other.

Thirteen figures show the buildup process of linear stage fluctuation pulses, variation of fluctuation pulse count with five factors, variation of the second threshold with four factors, measuring arrangement for generating fluctuation pulses, dual photon fluorescence picture of mode-locking pulses, and variation of the second threshold pump exceeding the threshold with dye concentration.

The authors are grateful to Wang Zhi'an [3769 3112 1344], Lan Guang [5663 0342] and Xue Songsheng [5641 2646 3932] for their assistance in operating computers. The article was received for publication on 22 July 1987.

High Accuracy Measurement of Laser Induced X-Ray Spectrum From GaAs Plasma

40090047d Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese
Vol 16 No 3, 20 Mar 89 pp 151-152, 134

[Article by Feng Xianping [7458 6343 1627], Xu Zhizhan [1776 5267 1455], Zhang Zhengquan [1728 2973 3123], Chen Shisheng [7115 2514 0524], and Zheng Danqing [6774 0030 7230] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Abstract] In the paper, first the blackness scanning curve of LPX spectrum is enlarged 30 times; the relative positions are then precisely measured. The purpose of amplification is to raise the measurement precision of the relative positions. On this basis, by comparing various data processing methods, the LPX spectral line of high precision arsenic gallium was obtained. By comparing data processing methods in various optical spectral experiments, the authors obtained a high-precision arsenic gallium laser plasma X-ray spectrum. Comparing with the theoretical value, the maximum relative error is not in excess of 0.03 percent.

Two figures show the spectrum of arsenic gallium LPX rays and the blackness scanning curve of the arsenic gallium LPX spectrum. One table lists data on the arsenic gallium LPX spectrum wavelength with different data processing methods. The paper was received for publication on 24 February 1988.

Relation Between Output Properties of Copper Vapor Laser and Its Resonator Length

40090047d Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 16 No 3, 20 Mar 89 pp 164-167

[Article by Ren Hong [0117 5725], Liang Peihui [2733 1014 6540], Shen Qimin [3088 3825 2404], and Sun Xiaoxiang [1327 2556 5046] of Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences; and Liu Jungqiu [0491 0193 4428] of Hefei Industrial University]

[Abstract] By changing the angle of longitudinal resonator, the authors studied the time-space property and output power of a copper vapor laser, proposing that the laser waveform is formed with the repetitive addition of nonsteady state optical pulses with opposite direction of propagation along the resonator axis. This concept can be used to satisfactorily explain the experimental phenomena.

Since copper vapor laser is of high gain and short pulse, change in length of steady resonator can result in significant change of time-space property of the copper vapor laser. In addition to the expected fact that the output power decreases with increasing resonator length, the experiment also reveals that the pulse waveform is formed with the repetitive addition of nonsteady state output light; the pulse waveform is formed with the repetitive addition of nonsteady-state output light, and modulated by longitudinal resonance cycle. At a particular resonator length, there is an optimal value for light beam orientation.

Five figures show an experimental arrangement, laser waveforms for different resonator lengths, a rectilinear correlation line indicating that a sharp pointed peak of the laser waveform is modulated by the resonator length cycle, theoretical and experimental curves for the output power varying with resonator length, and a curve correlating the resonator length and orientation.

Improved Polysilicon Etch Profile for 64K DRAM Devices Investigated

40080156a Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 10 No 2, Feb 89 (manuscript received 4 Sep 87) pp 117-123

[Article by Xu Qiuxia [1776 4428 7209], Feng Shumin [7458 3219 2404], and Zhou Suojing [0719 6956 0079], Research and Development Center of Microelectronics, Chinese Academy of Sciences, Beijing: "Cross-Sectional Profiles in Double-Layer Polysilicon VLSI Structures"]

[Text] Abstract: An investigation of the profiles of double-layer polysilicon [i.e., polycrystalline silicon] VLSI structures and the dry etching technology used to produce them has identified the optimum cross sectional structure. The greater the inclination angle of the polysilicon-I sidewall, the better the structure. Alteration of the etching conditions can be used to vary the horizontal-to-vertical etching rate ratio δ, satisfactorily producing a polysilicon-I sidewall angle α of about 49°. A two-step etch process is used for the polysilicon-II layer. This technique eliminates short-circuiting between adjacent word lines caused by polysilicon-II residue left on the polysilicon-I sidewalls when anisotropic RIE [reactive ion etching] is used in the 3-micron technology; in addition, it assures accurate control of the width of the word lines with only slight etching into the underlying SiO_2 layer. A practicable process structure and processing technology for VLSI device fabrication were worked out and 64K DRAM [dynamic random access memory] specimens meeting specifications were developed.

I. Introduction

Double-layer polysilicon-gate structures are used throughout VLSI integrated circuit technology, especially in the design and fabrication of DRAM devices. The first layer (referred to below as "polysilicon I") consists of the capacitor elements, while the second level ("polysilicon II") contains the MOS gates. The two polysilicon layers are separated by a thermal silica insulating layer. In 3-micron-and-less technology the polysilicon structures are processed by the anisotropic RIE technique, but problems may arise unless great care is used in design:

in particular, residues of polysilicon II may be left on the polysilicon-I sidewall, causing shortcircuiting and failure of adjoining polysilicon-II strips (i.e., the memory array word lines). W. Beinvogl[1,2] briefly reports a problem with such residues, but we have found no systematic discussion in the literature. We have systematically investigated ways of controlling the cross-sectional form of two-layer polysilicon structures and appropriate dry-etching techniques in a search for the structures best suited for elimination of polysilicon-II residues and have successfully applied them to the development of 64K DRAM devices.

II. Double-Layer Polysilicon Configurations Produced by Various Processes

The occurrence of polysilicon-II residues in double-layer polysilicon structures results from the processing methods used, the processing flowchart, and the process-control conditions, among other factors. In 5-micron technology, the 800-Å gate-oxide layer and the 3000-Å oxide layer serving as insulation between the two polysilicon layers are usually formed in the same process step by differential oxidation, and the nearly isotropic plasma etching method is used to etch the polysilicon, so that very little polysilicon-II residue is produced. In the 3-micron process, the thickness of the gate-oxide layer is reduced to 400-500 Å, while the oxide insulation layer between the polysilicon layers is still 3000 Å thick; producing two-high-quality oxide layers of such disparate thickness in the same step by the typical differential oxidation method is rather difficult. The technique can be improved by first growing a thermal SiO_2 layer of a specific thickness on the polysilicon I then performing continuous etching of the two-layered SiO_2/poly-Si material by the dry-etching technique, followed by differential oxidation to obtain the desired thickness of the SiO_2, then growing the polysilicon-II layer by LPCVD [low-pressure chemical vapor deposition], and finally using anisotropic RIE etching to produce the polysilicon-gate layout. Figure 1 [not reproduced] shows a cross section of the double-layer polysilicon structure produced by this process.

It will be seen that this technique overcomes the problem of single-step formation of two high-quality oxide layers whose thickness differs by a factor of about 7, but at the cost of producing a polysilicon-II residue. This is because in such a process it is difficult to etch away the polysilicon II that sinks below the SiO_2 layer and adheres firmly to the polysilicon I, and in addition because the anisotropic RIE technique used in the 3-micron technology for precise control of strip width in the etching of polysilicon II has a higher probability of producing polysilicon-II resident. In Figure 2 [not reproduced] the arrow shows polysilicon-II residue on the polysilicon-I sidewall of a real circuit.

Residue adhering to the polysilicon I may cause contact between adjoining polysilicon II strips (word lines), resulting in current

leakage or short-circuiting between them, as shown in Figure 3. This contact may degrade the quality of the circuit or cause it to fail.

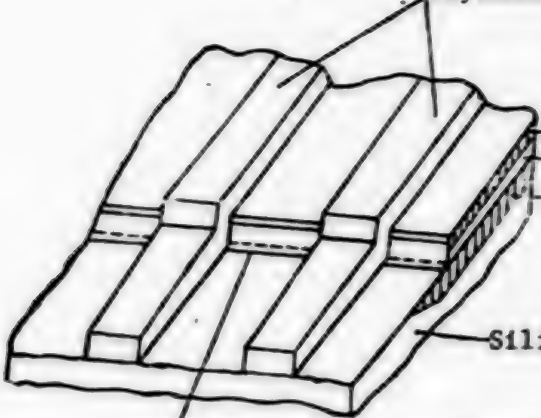

Figure 3. Short-Circuiting Between Adjacent Polysilicon-II Strips (Word Lines) Caused by Residue

The polysilicon-II sinking can be eliminated only by starting with a vertical two-layered SiO_2-polysilicon sidewall. We therefore made a detailed investigation of the anisotropic etching of SiO_2/poly-Si material. We found that with an appropriate etching power and gas pressure, anisotropic etching could be performed in a three-step process. In the first step, RIE was used to etch the SiO_2 layer above the polysilicon I. In the second step, argon-ion sputtering was used to etch the SiO_2-polysilicon transition layer. In the third step the RIE method was used to etch the polysilicon. Figure 4 [not reproduced] is an SEM [scanning electron microscope] photograph of the SiO_2/poly-Si vertical-sidewall profile.

A cross section of the double-layer polysilicon structure that resulted after differential oxidation is shown in Figure 5 [not reproduced]; it will be seen that bulk swelling of the polysilicon-I sidewall during the oxidation process has occurred and has made it slightly convex, so that the problem of polysilicon-II sinking has been completely eliminated.

Thus, the use of vertical polysilicon-I sidewalls, combined with two-step oxidation and a three-step etching process solves the problem of polysilicon-II sinking and adherence to the polysilicon-I sidewall. But a rather lengthy etching process is required, resulting in a tradeoff between control of strip width and etching into the underlying SiO_2 layer, and thus a more effective process structure is needed.

III. Optimizing the Profile of Double-Layer Polysilicon Structures

We propose a double-layer polysilicon structure with an angled polysilicon-I sidewall. Our investigations indicate that appropriate process alterations eliminate all of the tradeoffs that arise with a vertical polysilicon-I sidewall, yielding satisfactory optimization results.

A. Choice of the Angle α of the Polysilicon-I Sidewall

Because the polysilicon II is deposited by the LPCVD technique on already-formed polysilicon I, the results of RIE etching of the polysilicon II depend on the angle of inclination α of the polysilicon-I sidewall. Angle α is actually the included angle between the direction of RIE etching (perpendicular to the horizontal plane) and the direction of LPCVD growth (normal to all planes shown in the figure). These two directions are identical in the case of the horizontally deposited polysilicon II, and the etching results are optimal; but on the sidewall, the etching results depend on the angle of inclination, i.e., the included angle between these two directions. Clearly, the smaller the value of α the better. Figure 6 is a cross-sectional diagram of a two-layered structure with a slanting polysilicon-I sidewall to accompany our analysis of the problem.

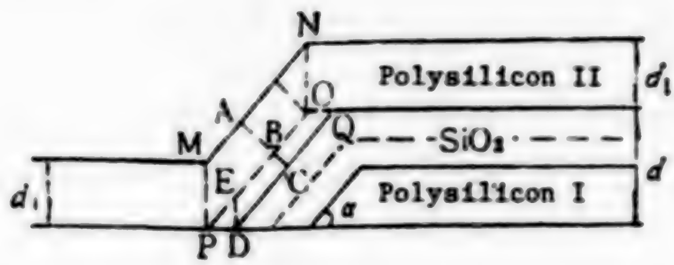

Figure 6. Profile of Double-Layer Polysilicon Structure With Sloped Polysilicon-I Sidewall

In the figure, d_1 is the thickness of the polysilicon II, d is the total thickness of the polysilicon I after differential oxidation, and α is the angle of inclination of the polysilicon-I sidewall.

When polysilicon II is grown by LPCVD, the growth rate is isotropic, so that the thickness of the polysilicon II both on the horizontal surface and in the direction normal to the sidewall will be d_1: thus, in RIE etching, which is directed perpendicular to the horizontal surface, when the polysilicon II on the upper and lower surfaces has been etched away, on the slanting surface only the polysilicon II in parallelogram MNOP will have been removed, and the material in parallelogram OPDQ will

remain. The cross-sectional thickness H in this zone is related to the angle α by the equation

$$H = BC = AC - AB = d_1(1 - \cos\alpha). \tag{1}$$

It is evident from Equation (1) that: (1) a decrease in α decreases H (the limiting value for α is 45°), with the result that the residue becomes thinner and only a small amount of etching is required to remove it; (2) $\alpha = 90°$, $H = d_1$, so that when the polysilicon-I sidewall is vertical, the residue has its maximum breadth and the etching time needed to remove it is at a maximum.

If we nonetheless attempt to use the RIE method to remove the residue, then the deepest horizontal etching depth h will be given by the formulas

$$h = DE = \frac{BC}{\cos\alpha} = \frac{H}{\cos\alpha} = d_1\left(\frac{1}{\cos\alpha} - 1\right) \quad \text{when } \alpha \text{ is such that}$$

$$d_1\left(\frac{1}{\cos\alpha} - 1\right) \leqslant d \tag{2}$$

$$h = d \quad \text{when } \alpha \text{ is such that} \quad d_1\left(\frac{1}{\cos\alpha} - 1\right) > d \tag{3}$$

From the equation $d_1\left(\frac{1}{\cos\alpha} - 1\right) = d$, we can find the critical value of α:

$$\alpha^* = \arccos\left(\frac{1}{1 + d/d_1}\right). \tag{4}$$

When $\alpha \geqslant \alpha^*$,

$$h = d$$

$$H = d_1(1 - \cos\alpha)$$

Thus, when the angle of inclination is greater than α^*, the horizontal thickness of the residue that must be removed is the same as when $\alpha = 90°$, and is equal to the step height d of the polysilicon I. The thickness of the residue $H=d_1\ (1 - \cos\alpha)$ is still related to α; thus α must be kept smaller than α^*, and making it as small as possible (but not smaller than 45°) minimizes the amount of residue that must be removed. But we also see that the RIE technique is not suited for etching away the residue, particularly when $\alpha > \alpha^*$, and plasma etching (PE) is more effective.

Let us now estimate α^* from the process parameters: we assume a polysilicon-I thickness of 4500 Å, of which about 1500 Å is removed by differential oxidation; we then grow an SiO_2 layer about 3000 Å thick,

so that the total step height is $d = 6000$ Å; and we assume a polysilicon-II thickness of 3700 Å. Substituting these figures into Equation (4), we obtain $\alpha^* = 68°$.

Thus we see that under the chosen process conditions the critical angle is 68°, so that the slope angle of the polysilicon I after patterning must be $\alpha < 68°$; angle α should be made as small as possible, but not less than 45°.

B. Process for Forming Sloping Polysilicon-I Sidewall

Let us attempt to adjust the horizontal to vertical etching rate ratio δ of the RIE method to obtain a satisfactory slope profile of the polysilicon-I sidewall. We can derive from the Arrhenius equation the following formulas[3] for δ:

$$\delta = \exp\left[-\frac{3\beta}{4}\left(\sqrt{1+(2r)^2}-1\right)\right] \qquad (5)$$

$$r = K'\frac{E_c}{p}\left(\frac{1+m^+/m^0}{Q}\right) \qquad (6)$$

where E_c is the field intensity in the shaded zone, which is proportional to the radio-frequency [RF] power density $\sqrt{P_{R\cdot F}}$; p is the gas pressure; Q is the collision cross section of the ions and neutral material; m^+ is the mass of a positive ion; m^0 is the mass of a neutral particle; $K' = \frac{e}{3KT_+}$, where T_+ is the ion temperature; and $0 < \beta < 1$. From Equation (5) we find that δ is dependent on the etching power and the gas pressure. The case $\delta = 0$ represents strictly anisotropic etching, in which the horizontal etching rate is zero; $\delta = 1$ represents the case in which the horizontal and vertical etching rates are equal. By adjusting the RF power density and the gas pressure, we can vary δ between 0.1 and 0.9. Under our experimental conditions, with a gas pressure of 600 m τ and a power W = 120 W, the polysilicon cross section had an angle of inclination $\alpha \approx 49°$, as indicated by SEM photographs (see Figure 7a [not reproduced]). If the working gas pressure is decreased to p = 5 m τ and the power is increased to W = 150 W, then the ion-bombardment capability will rise and the directionality of etching will be increased, with improved anisotropy, giving a vertical polysilicon profile as shown in Figure 7b [photograph not reproduced]).

Thus we see that appropriate choice of RIE etching conditions results in suitable values of α. We selected a profile angle of 49°. Experiments indicate that similar angles can be obtained with the PE process, but the linearity is inferior to that in the case described here.

In the differential oxidation performed immediately after the etch-forming of the sloped polysilicon-I sidewall, the lateral oxidation caused a slight additional upward bulge of the wall, increasing the slant of the profile; this result demonstrates that choice of an appropriate oxidation temperature and technique and a suitable intermediate oxide thickness will produce satisfactory results[4].

C. Etch-Forming of Polysilicon II

In the configuration in which the polysilicon-I layer has sloped sidewalls, the insulating SiO_2 layer between the two polysilicon layers and the thin gate oxide layer was grown simultaneously by the differential oxidation method, but the thickness difference between these two oxide layers and the oxidation rate ratio had to be suitably adjusted. A comparison of the flowchart developed for this double-layer polysilicon profile and the original flowchart is given in Table 1.

Table 1. Comparison of Optimized Profile Flowchart and Original Flowchart

Original Flowchart	Optimized Flowchart
Single-gate oxidation	Single-gate oxidation
↓	↓
LPCVD deposition of polysilicon I	LPCVD deposition of polysilicon I
↓	↓
Phosphorus redoping	Heavy phosphorus doping
↓	↓
Thermal oxidation	Photoetching
↓	↓
Photoetching	Dry etching of polysilicon I
↓	↓
RIE etching of SiO_2/Poly-Si I	Differential oxidation
↓	↓
Double-layer material	LPCVD deposition of polysilicon II
↓	↓
Differential oxidation	Heavy phosphorus doping
↓	↓
LPCVD deposition of polysilicon II	Photoetching
↓	↓
Heavy phosphorus doping	RIE two-step etching
↓	
Photoetching	
↓	
RIE etching	

In this flowchart the polysilicon II was formed by two-stage etching. The first stage consisted of low-gas-pressure anisotropic RIE etching of the polysilicon II, with a horizontal-to-vertical etching rate ratio $\delta \doteq 0.1$–0.2, keeping the amount of material removed at about 4/5 of the

total thickness. In the second step the gas pressure was increased and the power decreased to make the etching more nearly isotropic, with $\delta \doteq 0.8$, in order to etch away the remaining polysilicon II. The objectives of the two-step etching process were to assure that the width of the silicon gates could be controlled and to remove polysilicon-II residue efficiently from the polysilicon-I sidewall. Figure 8 [not reproduced] is an SEM photomicrograph of the good double-layer polysilicon profile obtained with the optimized pattern process. Not only is the sinking of polysilicon II below the oxide layer that was observable in Figure 1 eliminated, but the slope of the sidewall minimizes the problem of polysilicon II residue from the RIE process.

Figure 8b is an SEM photograph of a real circuit with the optimum profile; it is readily seen that no polysilicon-II residue is present on the polysilicon-I sidewall.

IV. Brief Conclusions

We have investigated double-layer polysilicon-structure profiles and patterning processes in 3-micron technology in order to resolve the tradeoff between precise strip-width control and the presence of polysilicon-II residue on the polysilicon-I sidewalls that was identified in research on double-layer polysilicon VLSI structures.

Inspection of SEM photomicrographs of the profiles of specimens prepared by the 3-micron technology revealed that polysilicon-II residues occurred on the polysilicon-I sidewalls and constituted the main factor producing current leakage or short-circuiting between adjoining polysilicon-II strips (word lines). Part of the polysilicon-II residue sank into pits on the polysilicon I, and the rest adhered tightly to the polysilicon-I sidewall, as a result of incomplete removal by RIE etching.

Our analysis shows that the changeover to a vertical polysilicon-I sidewall, with double oxidation and three-step etching, eliminates residue, but gives rise to two problems. The first is that lateral etching makes the 3-micron-wide silicon gates noticeably thinner, and the strip width cannot be precisely controlled, which is deleterious to circuit characteristics and chip yield. Second, excessive etching may extend into the underlying oxide layer. As a result, the process is hard to use in practice.

We have suggested a structure in which the first polysilicon layer has a slant sidewall. Calculations indicate that under the stated process characteristics, a structure with an angle of inclination $\alpha < 68°$ is effective, and that the effectiveness increases as the angle decreases, with a limiting value of 45°. An analysis of RIE etching indicates that by altering the gas pressure and the radio-frequency power it is possible to adjust the horizontal-to-vertical etching rate ratio δ, thus obtaining a satisfactory polysilicon-I sidewall. A reproducible

value of $\alpha = 49°$ was obtained under our process conditions. The polysilicon II was etched by a two-step dry process. This method effectively removed polysilicon-II residue and in addition assured that the width of the polysilicon-II strips could be controlled, while resulting in only slight etching into the underlying oxide layer. We have described a process flowchart suitable for this optimized profile and presented structural diagrams of the optimized profile and SEM photomicrographs of real circuits. This investigation has provided a suitable process structure and processing technology for VLSI circuit fabrication and has led to the successful development of 64K DRAM specimens that met specifications.

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New YBaCuO Thin-Film Three-Terminal Device Described

40080156b Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 10 No 2, Feb 89 (manuscript received 6 Jun 88) pp 141-142

[Article by Xu Hongda [1776 7703 6671] and Wang Sen [3769 2773], Institute of Semiconductors, Chinese Academy of Sciences, Beijing, and Zhao Bairu [6392 2672 0320], Yuan Caiwen [5913 1752 2429], and Li Lin [2621 2651], Institute of Physics, Chinese Academy of Sciences, Beijing: "A New $Y_1Ba_2Cu_3O_{7-\delta}$ Thin-Film Three-Terminal Device"]

[Text] Abstract. A new YBCO [$Y_1Ba_2Cu_3O_{7-\delta}$] thin-film three-terminal device in which the semiconductor silicon film and the YBCO film are in direct contact has been developed and has proved to be capable of switching and amplification of weak signals. The device can operate either at the temperature of liquid nitrogen or at room temperature and is simple to fabricate.

I. Materials and Device Structure

The three-terminal device described here is prepared by sputtering a $Y_1Ba_2Cu_3O_{7-\delta}$ thin film onto an $SrTiO_3$ monocrystal substrate of specific orientation; annealing at 800-900 °C results in a film 0.5 μm thick. Photolithography and etching resulted in device patterning of the desired dimensions, and ohmic contacts were applied to two of the electrodes to form current terminals. A semiconductor Si film was applied directly to the YBCO film between the two electrodes and an ohmic contact was placed on it to form a gate terminal. The structure of the device is shown in Figure 1.

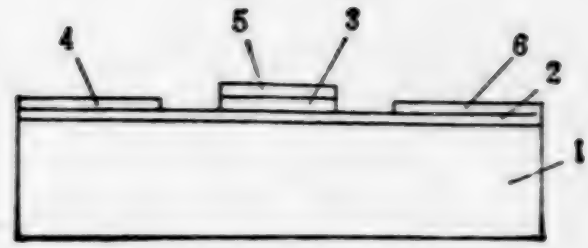

Figure 1. Structure of the Three-Terminal Device

1. $SrTiO_3$
2. $Y_1Br_2Cu_3O_{7-\delta}$
3. Silicon
4-6. Ohmic contacts

The details of the fabrication process will be described in a separate article.

II. Device Characteristics

The salient features of the device are the fact that a YBCO film is used in its fabrication and that it has new properties, resulting from its nonsuperconducting characteristics; it is not a typical superconducting three-terminal device.

The device's volt-ampere characteristics differ somewhat from that of ordinary semiconductor field effect transistors (FET's) in that it does not exhibit current saturation (see Figure 2 [not reproduced]). The control characteristics of the control terminal, shown in Figure 3 [not reproduced] indicate that the current at the conductive terminal decreases when a negative step bias is applied. This property was observed at the temperature of liquid nitrogen, but the room-temperature behavior is similar, indicating that the device can operate at either 77 K or room temperature.

When a 1-volt bias is applied to the conductive terminal, only 10^{-8} V need be applied to the control terminal to open the circuit. Because the device is nonlinear, its current gain factor varies with the voltage applied to the current terminals; initial measurements indicate that a typical forward current gain factor h_{fe} for the device is several tens to over 100, with an internal power consumption of 10^{-5} W.

The operating mechanism of the device will be discussed in a separate article.

III. Conclusions

The three-terminal device prepared with a YBCO thin-film base material directly overlain by a thin semiconducting silicon film is a nonsuperconducting device with great applications potential; its features include weak-signal amplification and switching and low power consumption, and its applications in weak-signal processing systems and digital circuits should improve circuit performance.

Further research on the physics and applications of the device is planned.

The authors are grateful to Comrades Lu Ruilan [6424 3843 5695], Zhang Chunhua [1728 2504 5363], and Wang Hongjie [3769 4767 2638] for help in fabricating the device, and to Comrades Zhang Yingzi [1728 7751 1311], Zhao Yuying [6392 3768 5391], and Gau Ju [7559 3515] for help in materials preparation.

Fabrication, Characteristics of 1.5-Micron InGaAsP/InP P-Substrate Buried Crescent Laser

40080156c Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 10 No 2, Feb 89 (manuscript received 10 May 88) pp 143-145

[Article by Peng Huaide [1756 2037 1795], Ma Chaohua [7456 2600 5478], Wang Xiaojie [3076 1321 2638], Zhang Shenglian [1728 4141 1670], Lu Hui [0712 0583], Wang Liming [3769 7787 2494], Wu Shuzhen [2976 3219 3791], Ma Xiaoyu [7456 7522 1342], and Zhang Hongqin [1728 3163 6860], Institute of Semiconductors, Chinese Academy of Sciences: "A 1.5-Micron InGaAsP/InP P-Substrate Buried Crescent Laser"]

[Text] Abstract. The fabrication and characteristics of a P-substrate 1.5-micron buried crescent laser are described. The typical threshold current in room-temperature continuous-wave [CW] operation is 20 mA, with values as low as 15 mA in some specimens; the emission wavelength is 1.53 μm and the maximum CW operating temperature is 105°C.

In recent years, p-InP substrates have been widely used in fabricating long-wave laser devices of various structure[1,2]. The advantage of using p-type substrates to prepare buried-stripe lasers is the low leakage current of the current-blocking region, allowing distinct improvements in laser output characteristics.

As shown in Figure 1, the PBC (p-substrate buried crescent) laser is a two-step epitaxially grown structure in which a p-InP buffer layer about 1 micron thick, a 1-micron n-InP layer and a 2-micron p-InP current-blocking layer are grown successively in the first LPE [liquid phase epitaxy] cycle, followed by a 0.5-micron InGaAsP layer as a mask for etching the InP. Finally, a stripe window 1 micron wide is etched in the <011> direction: selective etching is used to etch the window in the InGaAsP layer, after which HCl is used to each V-shaped grooves 1.5-2 microns wide and about 4 microns deep in the InP, and the InGaAsP layer is removed for a second cycle of epitaxy. In the groove are successively grown a p-InP buffer layer, a crescent-shaped InGaAsP active layer, and an n-InP buffer layer. Care is taken that the active region is above the interface between the n and p current-blocking

regions in order to minimize leakage current. The four layers are grown at temperatures below 590°C. A cross-sectional photograph of a PBC epitaxial wafer is shown in Figure 2 [not reproduced]. The active region has a width of about 2 microns and the crescent is about 0.2 micron thick at its center. It is subsequently thinned, n and p electrodes re produced, and it is then cleaved to form chips with a cavity length of about 200 microns and soldered to an indium-coated copper heat sink.

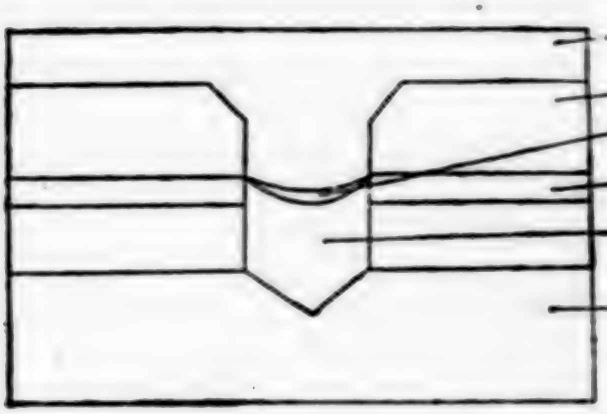

Figure 1. Structure of p-Substrate Buried Crescent (PBC) Laser

We produced four wafers, initially producing only a small number of lasers to investigate the uniformity of the threshold current. The wafers after the second epitaxial stage measured about 5 x 5 mm; and each chip was cleaved into two long stripe 0.2 mm wide, from which about 36 chips could be cut. They were then mounted and the threshold current for CW operation was determined. The percentage of lasers with threshold values of 20 mA or below was high for each wafer: for example, wafer No 18 produced 11 chips with I_{th} of 15-18 mA, indicating good threshold stability.

The lasers had a typical threshold current of 20 mA, with values falling as low at 15 mA. Figure 3 shows the light-output characteristics versus current. The output power in CW operation exceeded 10 mW. Figure 4 shows light-output versus current as a function of temperature. The maximum temperature for CW operation was as high as 105°C in some cases. Figure 5 shows a typical emission spectrum. The peak is at 1.533 microns, and a considerable percentage of the chips showed a DC single-longitudinal-mode characteristic, but as a rule there were 2 or 3 longitudinal modes.

Figure 3. Light Output vs Current

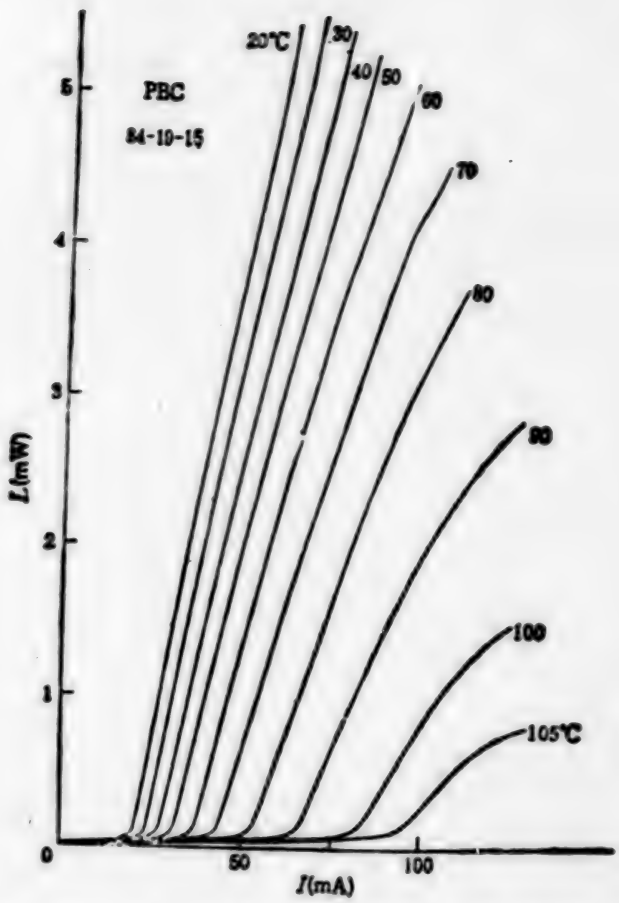

Figure 4. Light Output vs Current as a Function of Temperature

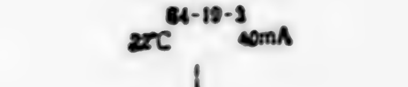

Figure 5. Emission Spectrum

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Monolithic Integrated InGaAs PIN-JFET Photoreceiver Described

40080156d Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 10 No 2, Feb 89 (manuscript received 9 Sep 87) pp 148-152

[Article by Zhang Yonggang [1728 3057 0474], Fu Xiaomei [1381 1420 1188], and Pan Huizhen [3382 1979 3791], Shanghai Institute of Metallurgy, Chinese Academy of Sciences: "Design and Fabrication of a Monolithic Integrated InGaAs PIN-JFET Photoreceiver."

[Text] Abstract. The design and fabrication of a new monolithic integrated InGaAs PIN-JFET [positive-intrinsic-negative junction field-effect transistor] photoreceiver are reported. To assure that the optoelectronic and electronic devices are compatible for integration, a new technique of planar epitaxy on a substrate was developed, resulting in device of quasiplanar structure; the main characteristics of the device were predicted from theory and a near-optimum current carrier density was chosen. In the monolithic devices the PIN photodiode had a quantum efficiency of 57% at 1.3 microns, the dark current at -5 V was less than 100 nA [nanoamperes], and the JFET transconductance was 37 mS/mm [millisiemens/millimeter], in agreement with the predicted values. Tests of the device gave results consistent with expectations.

I. Introduction

As lightwave communications and optical signal processing move to increasingly higher speeds, optoelectronics integrated circuits (OEIC's) have been attracting increasing attention. OEIC's have numerous advantages over discrete components; the subject has been discussed in considerable detail by Wada, et al.[1] In the InP series of materials, InGaAs has a very high electron mobility and is suited for high-speed electronic components. In addition its bandgap [energy] is 0.75 eV and it is suited for 0.9-1.65-micron photodetectors. As a result, long-wave photoreceiver chips based on InGaAs have excellent development prospects, and PIN-JFET's are a particularly promising type. Such devices have already been described abroad,[2-5] but relatively little work has been done on the subject in China. In the present paper we

describe the design of a quasiplanar-structure monolithic InGaAs PIN-JFET photoreceiver and report preliminary fabrication results.

II. Device Design

The first problem that must be solved in OEIC design is compatibility of the optoelectronic and electronic components in terms of materials and device structure. In the case of PIN-JFET monolithic IC's, one must assure that the PIN photodiode and the JFET are compatible in terms of active zone thickness and carrier concentration. We shall discuss these problems below.

For the JFET, the active zone must generally have a high carrier concentration to achieve high transconductance. But the carrier concentration in the active zone of the PIN photodiode must not be excessively high, or the dark current and junction capacitance will rise and the quantum yield will fall. We therefore calculated the relationship of the JFET transconductance and saturation current to the PIN diode's dark current and active-zone carrier concentration; the results are shown in Figure 1.

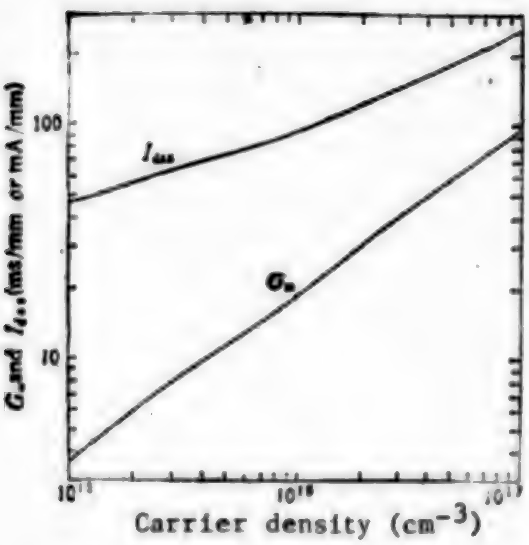

Figure 1a. Transconductance Per Unit Gate Width G_m and Saturation Voltage I_{dss} of JFET as a Function of Channel Carrier Density

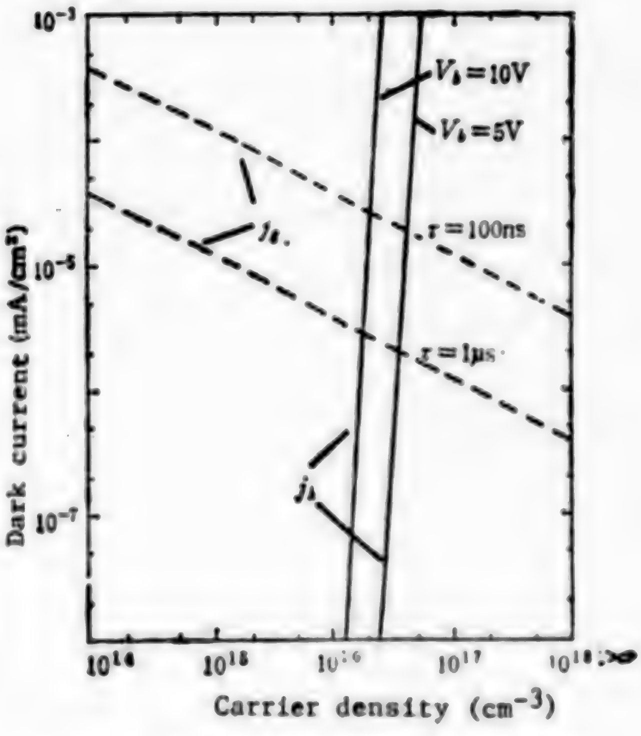

Figure 1b. Dark-Current Density of PIN Photodiode as a Function of Active-Region Carrier Density

Figure 1a shows the JFET transconductance per unit gate width G_m and saturation current I_{dss} as a function of the channel carrier density. The calculations are based on the method of Kang Baowei[6]: first, calculations are made by the Shockley theory with the constant-mobility and gradual-channel approximations, after which the velocity saturation effect is calculated, and the velocity-field characteristic of InGaAs is used in the hyperbolic velocity-field approximation to correct the calculation result. The calculated saturation field for InGaAs was 3.3 kV/cm, and the low-field mobility and charge carrier density are given by Equation (1). This formula was obtained by curve fitting to results obtained from Hall measurements on an InGaAs epitaxial chip. In the calculations we assumed a JFET pinchoff voltage of -4 V and a gate voltage of 0 V, with the gate length and gate-source distance both equal to 4 microns; we also allowed for the gate-source series resistance and for the source ohmic-contact resistance.

$$\mu_{\circ} = 15000/\sqrt{1 + N_D/(10^{15} + N_D/5.5)}\ \mathrm{cm^2/V \cdot S}, \quad \text{where } N_D \text{ is in units of } \mathrm{cm^{-3}} \qquad (1)$$

The dark current of the PIN diode is made up of diffusion, generation-recombination, tunneling and surface-current-leakage components.[7] A quantitative analysis of these factors indicates that the tunneling current and the generation current caused by deep-energy-level impurities in the potential barrier region and by defect recombination centers and the like play the dominant role; Figure 1b shows the computed results. It will be seen that when $N_D > 2 \cdot 10^{16}\ \mathrm{cm^{-3}}$, the tunneling current density j_k will increase rapidly and will be considerably affected by the bias voltage V_b. The generation current density j_g is governed primarily by the effective lifetime τ of indirect combination caused by the recombination centers, and as a result, during processing every effort should be made to avoid introducing deep irpurities and defect recombination centers.

It will be seen in Figure 1 that to allow for the characteristics of both the PIN photodiode and the JFET, a carrier density of $1\text{-}2 \cdot 10^{16}\ \mathrm{cm^{-3}}$ in the InGaAs is ideal and results in good overall device characteristics; the device-breakdown potential will exceed 10 V, which meets requirements.

As regards the thickness of the active layer, in the JFET's the gate zone must be rather thin, otherwise the pinchoff voltage and the saturation current will be excessively large and the PIN diode will need a rather thick light-absorption zone in order to allow full absorption and increase the quantum yield. We have therefore designed and developed a new process that makes use of a patterned substrate for planar epitaxy. Taking advantage of the anisotropic growth characteristics of LPE [liquid-phase epitaxy], a single epitaxial growth step is used to produce an epitaxial wafer with epitaxial layers of

different thickness and with planar surface layers in order to allow for subsequent patterning.

Figure 2 illustrates the structure of the monolithic device that we designed and fabricated. The JFET gate length and gate-source distance are both 4 microns, the gate width is 100 microns, and the gate region thickness is about 1.4 microns; the light-sensitive zone of the PIN diode has a diameter of 80 microns and is about 5 microns thick. In order to decrease distributed capacitance, air-bridge connections were used, minimizing the area of the active zone. Evaporated Ti/Au electrodes were used to increase adherence and meet the needs of the wet-etching technique that was used. The drain electrode of the JFET and the negative electrode of the PIN photodiode were separated, unlike devices described by other investigators;[2-4] this arrangement made for greater convenience in circuit connections and allowed optimum adjustment of the working characteristics of the two devices.

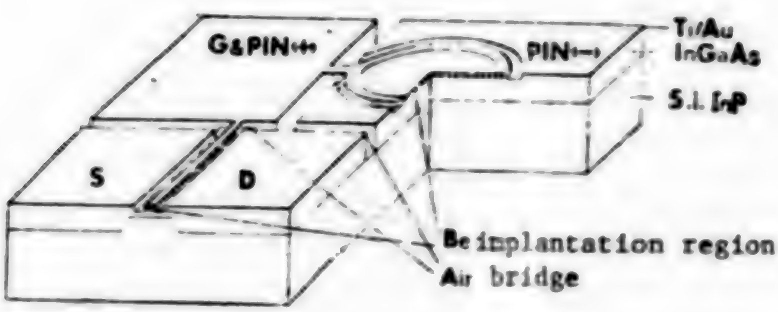

Figure 2. Structure of Quasiplanar Monolithic Integrated InGaAs PIN-JFET Photoreceiver

III. Device Fabrication

We first etched a ridged-strip structure 30 microns wide, 5 microns high, and 500 microns apart on the (100) face of a semi-insulating InP substrate, then performed planar LPE growth.[8] A photomicrograph of a cleaved epitaxial chip is shown in Figure 3 [not reproduced]. The epitaxial chip was then lightly etched to thin it to a JFET gate-zone thickness of about 1.4 microns, after which a layer of SiO_2 was deposited, the ion-implantation zone was etched on the SiO_2, and selective beryllium-ion implantation[8] with an implantation voltage of 30 keV at a dose of $1\cdot10^{14}$ cm^{-2} was performed. The chip was then annealed, resulting in a p-n junction depth of about 0.6 micron. After removal of the SiO_2, Ti/Au metallization was applied by evaporation, after which the electrode pattern was etched on, followed by the isolation grooves and the optical-fiber coupling holes; the electrical characteristics of the completed chip were then determined.

IV. Results and Discussion

Figure 4 [not reproduced] shows the output characteristics of the JFET component of the chip. With a carrier density of $2 \cdot 10^{16}$ cm^{-3}, the transconductance at zero gate voltage was 34 mS/mm, in agreement with the predicted value. The PIN-photodiode quantum yield at 1.3 microns was 57%; the addition of an antireflective coating would further increase the quantum yield. The dark current at -5 V was less than 100 nA. We also tested the photoreception characteristics of the photodetector, obtaining results consistent with predictions. Figure 5 shows the measured results and a schematic of the measurement setup.

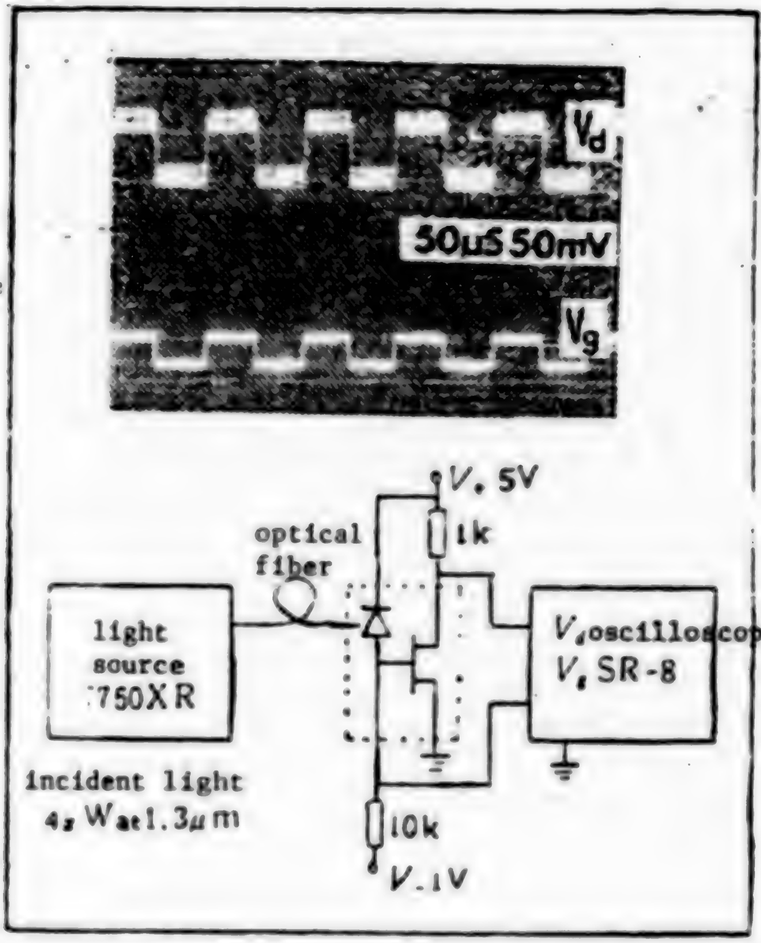

Figure 5. Measured Photodetection Characteristics of Monolithic Integrated Photoreceiver and Schematic of Measurement System

Under existing process conditions, if the JFET gate width were increased to 650 microns, then the figure of merit could be optimized. The

calculated cutoff frequency for this case is 1 GHz, so that the device could be used in 140 Mbit/sec [i.e., DS4] systems. Further improvement of the process, the use of self-aligning structures, a decrease in gate length and separate control of the carrier densities in the JFET gate region and the PIN-diode absorption region could greatly increase the speed of the device, possibly making it usable in superhigh-speed systems. The use of existing design structures to integrate several JFET's and PIN diodes into a complete photoreceiver module would result in even greater convenience in application. Research in these areas is now in progress.

V. Brief Conclusions

1. A new design and new processes were used in the fabrication of a monolithic integrated InGaAs PIN-JFET photoreceiver of quasiplanar structure.

2. We used the new process of planar epitaxy on a patterned substrate and chose an appropriate carrier density so as to make the PIN diode and the JFET compatible.

3. The JFET's transconductance was 34 mS/mm ($N_D = 2 \cdot 10^{16}$ cm^{-3}, $L = 4$ μm), the quantum efficiency of the diode was 57% at 1.3 microns, and its dark current was less than 100 nA at -5 V. These figures were in agreement with predictions.

4. The measured photodetection characteristics were consistent with expectations.

The authors are grateful to Comrade Chen Ruyi [7115 1172 1942] of Beijing Normal University for help with the Be ion implantation.

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Method for Etching Submicron Vertical Silicon Walls

40080156e Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 10 No 2, Feb 89 (manuscript received 20 Aug 87) pp 158-160

[Article by Tang Yusheng [3282 3768 3932] and Jiang Jianfei [5592 1646 7378], LSI Microfabrication Institute, Shanghai Jiaotong University: "A Technique for Etching Submicron Vertical Walls"]

[Text] Abstract: The production of submicron vertical silicon walls is a key process in vertical-silicon-film-coupled Josephson junctions. Using ordinary photolithographic equipment, a process for engraving submicron silicon walls on <100> silicon wafers was developed. Ordinary photoetching techniques are used to etch a rather wide wall zone. Multiple-implantation doping of the nonwall zone is followed by high-temperature horizontal impurity diffusion and selective etching of the doped zone. The final step is thinning by high-temperature oxidation. The experimental results indicate that the method can be used to prepare silicon walls with a width of 0.29 micron and a height of about 1 micron and that there is potential for further improvement.

The preparation of submicron vertical silicon walls, a key process in the fabrication of Josephson junctions coupled by a thin silicon film, requires a wall thickness of less than 0.5 micron and a wall height of about 1 μm, with vertical sides. Raley, et al.[1] used <110> silicon wafers as a substrate and took advantage of the difference in the rates of etching of the <110> and <111> directions by 36% KOH solution (at a constant temperature of 60°C, ratio of etching rates in the two directions 50:1) to produce vertical thin-silicon walls. But this process depends on the use of electron-beam exposure equipment to produce wall thicknesses of about 1 micron, followed by doping and oxidation to reduce the wall thickness to less than 0.1 micron. In addition, it also requires that the walls be strictly parallel to the <110> direction; otherwise the wall surface will have a sawtoothed configuration.[2] The present authors combined ordinary photoengraving, multiple-implantation doping, high-temperature horizontal impurity

diffusion, selective etching of the doped areas, and thinning by high-temperature oxidation into an integrated process for preparing vertical submicron silicon walls in <100> silicon wafers.

In wet etching of monocrystalline silicon, the etching rate is dependent on the crystal direction and impurity concentration.[3-5] Our method of preparing submicron silicon screens makes use of this fact. Bean states[5] that when <100> monocrystalline silicon is etched in an $HF:HNO_3:CH_3COOH$ solution in 1:3:10 proportions, the etching rate depends on the impurity concentration. The etching rate was 2.5 μm/minute for heavily doped p^+ and n^+ regions with impurity concentrations exceeding $5 \cdot 10^{18}$ cm^{-3}, but was only 1000 Å/minute in regions with concentrations of less than $5 \cdot 10^{18}$ cm^{-3}. Thus the difference between the etching rates of heavily and lightly doped regions is a factor of 25, and we can conclude that etching essentially ceases at a concentration of $5 \cdot 10^{18}$ cm^{-3}. Thus, if we use <100> silicon wafers, by selective surface doping and control of the depth of doping, we can produce selective surface and vertical etching. Horizontal diffusion from two heavily doped zones on a surface can be used to decrease the width of the undoped regions between them. Because the impurity-diffusion coefficient at high temperatures depends on the impurity concentration,[6] in order to assure that the impurity horizontal diffusion rate will be the same at all points in the vertical direction, thus resulting in vertical walls, vertically constant impurity concentrations must be produced. As a result, our submicron-silicon-wall preparation technique consists of the following steps: (1) etching a rather broad wall zone, (2) multiple implantation doping of the non-wall zones to assure that all vertical points in the doped zones have the same impurity concentration, (3) the use of high-temperature horizontal drive-in of the impurity to decrease the width of the wall zones, and (4) etching in 1:3:10 solution. This process yields submicron silicon walls. If the wall zone still does not meet requirements, high-temperature oxidation can be used to thin the walls further.

In the experiments we used a <100> silicon wafer 35 [mm] in diameter with a resistivity of 6-9 ohm-cm. The wafer was subjected to dry-wet-dry oxidation at 1050°C at an oxygen flow rate of 20 liters/hour for 15, 90 and 15 minutes. The oxidation layer was 9500 Å thick. The photoetching of the wall zone was performed with an ordinary Laodong-brand photoetching device. The mask was an industrial ruled plate on which the thinnest line was 3.5 microns wide. The SiO_2 was etched with $HF:NH_4F:H_2O$, in proportions of 3 ml:6 g:10 ml, at a constant temperature of 40°C. Multiple-implantation doping with boron at three different energies (150, 100 and 50 keV) was used, with a dose of $1 \cdot 10^{15}$ cm^{-2} in each case. After implantation was complete, annealing was performed successively at 950°, 1000°, 1050° and 1100°C for 30, 60 and 90 minutes, respectively [as published] in N_2 ambient at a flow rate of 20 liters/hour. The SiO_2 was stripped from the specimen, which was then etched in 1:3:10 solution at a constant temperature of 30°C, usually for 3 minutes.

Figure 1 [not reproduced] shows silicon walls obtained by etching in 1:3:10 solution after boron implantation and annealing at 950°C in an N_2 ambient for 30 minutes. The wall thickness is 0.84 micron and the height is close to 1 micron. It will be seen that the edges of the walls are close to vertical and that the bottom surfaces are relatively even. Further oxidation at 1050°C at an oxygen flow rate of 20 liters/hour for 30 minutes in dry oxygen, 180 minutes in moist oxygen, and 15 minutes in dry oxygen further narrowed the walls (see Figure 2 [not reproduced]). It can be seen that the wall width is 0.57 micron and that the wall height is essentially unchanged. This result indicates that high-temperature oxidation is effective for thinning the silicon walls. By raising the diffusion annealing temperature, it is possible to obtain even narrower walls, as shown in Figure 3 [not reproduced]. In this case the wall thickness is 0.29 micron and the height is about 1 micron. This result was obtained by raising the diffusion temperature to 1050°C; the length of the diffusion treatment and the conditions of high-temperature oxidation were the same as for the specimen shown in Figure 2.

The results illustrated above indicate that our technique of selective etching of doped areas can be used to produce submicron vertical silicon walls. Because impurity diffusion and thinning by high-temperature oxidation are microincremental processes, and because of the excellent capabilities of selective etching, the wall thickness can be controlled very precisely and a high success rate and good reproducibility can be obtained. In addition, the orientation of the wall is not confined to a particular crystal direction, a feature that is convenient for integration of vertical-silicon-film-coupled Josephson junctions.

It will be seen from the experimental results that the edges of the walls are not sufficiently vertical. One reason is that the vertical profile of the successively implanted impurities was not highly rectangular; thus, further investigation of the choice of multiple implantation energies and doses will be required. Another factor is that the boron-diffusion profile is described by the error distribution.[6] To compensate for this deficiency, in the multiple-implantation process the highest energy should be coupled with a rather high dose so that the implanted impurities have a nonrectangular distribution with a higher concentration in the lower zone, thus accelerating horizontal diffusion in the lower zone and increasing the verticality of the wall. When the wall need not be very high, arsenic can be implanted; its vertical diffusion cross section is rectangular.[6,7] This is another step that must be taken in order to make the walls thinner.

The authors are grateful to Engineer Chen Kangmin [7115 1660 3046] of the Shanghai No 5 Radio Plant and to Comrades Xu Qinyao [1776 4440 5674] and Dai Peixing [2071 1014 5281] of the Shanghai Jiaotong University Physics Department for their assistance in the experiments.

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Microcomputer-Controlled GaAs Vapor-Phase Epitaxy Equipment Developed

40080165b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 14, 12 Apr 89 p 14

[Summary] The JW0009 microcomputer-controlled large-diameter gallium arsenide (GaAs) vapor-phase epitaxy machine, independently designed and developed at Nanjing Research Institute 55 under the Ministry of Machine-Building & Electronics Industry recently passed its technical appraisal in Nanjing. This equipment is used for manufacturing special-purpose large-area (maximum epitaxial chip diameter of 3 inches) homogeneous GaAs materials. Vapor-phase etching and the deposition of the buffer layer, active layer, and contact layer are all carried out in one continuous process.

This equipment, which has been in trial use for over a year, has produced test batches of FET [field effect transistor] devices which have exhibited quite good performance characteristics. Hopefully the equipment will also be used for manufacturing monolithic microwave integrated circuits [MMIC's].

Da-Qin Railroad Gets Longest Completed Domestic Fiber-Optic Line

40080164a Beijing DIANZI SHICHANG [ELECTRONICS MARKET] in Chinese 30 Mar 89 p 1

[Article by Xiao Zhong [2556 6988]]

[Summary] China's most technologically advanced and longest completed fiber-optic communications line--a 410-km line for the Da-Qin Railroad--is now in operation. This digital communications system, which meets advanced international standards for the eighties, not only satisfies the Da-Qin Railroad's needs for communications commands and remote-controlled communications, but also provides a trunkline circuit from Beijing to the Northeast and Northwest.

Coastal Satellite Communications Station to Be Set Up

40080164b Beijing DIANZI SHICHANG [ELECTRONICS MARKET] in Chinese 30 Mar 89 p 1

[Article by Jie Peizhi [6043 1014 1807]]

[Text] The Norwegian firm EBNERA recently formally turned over to China a coastal satellite communications ground station. This station is part of a maritime satellite communications system being supplied by the Inmarsat Organization. To be installed in Beijing, the station will handle traffic from the mainland to ships in the Pacific and Indian Oceans.

Scheduled to be in operation in early 1989, the station includes two 13-meter parabolic-surface antennas, transceiver equipment, a microcomputer control system, and a radio contact system for linking Inmarsat to Beijing. This will join the mainland into the international telecommunications network. [See also earlier report published in JPRS-CST-88-006, 5 Apr 88, p 165.]

First Independently Designed Underwater Optical Cable Passes Acceptance Check

40080164c [Editorial Report] Shanghai WEN HUI BAO in Chinese of 28 Mar 89 carries on page 1 a 200-word article announcing the Shanghai Cable Plant's development of China's first independently designed long-distance, high-capacity river (i.e., underwater) optical cable, which passed inspection by the Ministry of Posts & Telecommunications. This optical cable, which can simultaneously carry 9600 telephone circuits and 20 color TV signals, will soon be installed under the Changjiang between Hefei and Wuhu.

Additional details not published in an earlier report [see FBIS-CHI-89-066, 7 Apr 89, p 68] on this topic follow. The cable, which will be 5 kilometers in length and which will be installed 30 meters below the river's surface, consists of 10 hair-thin achromatic transparent single-mode optical fibers which will transmit information at the 140 Mb/s [i.e., DS4] rate. In addition to telephone and color TV signals, the cable can carry microcomputer-networked data signals, high-frequency signals, and encrypted signals.

Successful Trial Broadcast of Domestically Made Satellite Ground Station in Yunnan

40080178a Beijing ZHONGGUO DIANZI BAO in Chinese 18 Apr 89 p 1

[Article by Cao Qunshan [2580 5028 1472] and Cao Guizhi [2580 2710 5347]]

[Text] After over a month of trial broadcasting, all of the equipment for the Yunnan Satellite Television Ground Station--China's first such station built entirely from domestically made equipment and parts--is operating stably and reliably. According to reports from [television] receive-only [TVRO] ground stations in all parts of Yunnan [Province] and in some areas of Qinghai [Province], the quality of the received images is superior to that of the Central Television Station's channels 1 and 2 relayed through the transponders of China's satellite [i.e., "Chinasat-1"] located at 87.5 degrees [east longitude].

The [construction of the] Yunnan Satellite Television Ground Station was a project ratified by the Yunnan provincial government. Chief contractor was the China Tongguang [6639 1639] Electronics Company, and the construction was carried out jointly by Research Institute 54 of the Ministry of Machine-Building & Electronics Industry, Plant 4111, and Plant 4191. The 11-meter antenna used at this station was designed by Institute 54 to incorporate advanced technologies meeting mid-eighties international standards. The [antenna] feed utilizes dual circularly/dual linearly frequency[-independent] polarized [shuang yuan shuang xian pinlü jihua] multiplexing technology; the polarization mode can be quickly changed at the monitoring station. Construction and design of the antenna are reasonable and it has a pleasing external appearance. After network-entry testing and verification, it has met network-entry requirements. The high-power amplifier, which has a domestically made klystron, permits one to preset at will six frequency-channel values within a 500-MHz band. Audible noise that can continuously cause headaches to operating personnel is lower than the national-standard requirement. There is a backup for every part of the equipment, and when a fault occurs in the main system, one can automatically switch over to the spare system.

The successful trial broadcasting of the Yunnan station not only will permit Yunnan Province's 35 million people to view the provincial television programs, but also breaks a new path in the campaign to implement complete domestic production of China's satellite TV ground station [equipment]--the path of short project time, low investment, and high quality.

Domestically Made Direct-Broadcast-Satellite TV Receiver

40080178b Beijing ZHONGGUO DIANZI BAO in Chinese 18 Apr 89 p 1

[Article by Song Jianqin [1345 1696 0530]]

[Text] In March of last year [i.e., 1988], the WL-1 direct broadcast satellite [DBS] television receiver, developed and manufactured by the Xiangfan [5980 2868] Television Plant, was awarded a third-class prize for scientific and technological progress by the Hubei Provincial People's Government.

Within specified technical parameters, this set can receive television programs from the Soviet Union. Its main uses are in defense research, education, information exchange, and similar areas. In the time since the receiver was developed [and distributed], it has been quite favorably regarded by authorities in the educational and scientific research fields.

New Achievements in Optical Communications

40080178c Beijing KE JI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese 7 May 89 p 1

[Article by Wu Jianfei [0702 0494 7378]: "Three Products Developed by Beijing Institute of Posts & Telecommunications' Teaching and Research Section for Optical Communications Are Accredited"]

[Text] Three products of high-tech research and development at the Beijing Institute of Posts & Telecommunications' Teaching and Research Section for Optical Communications--including a "long-wavelength indium-doped bismuth-calcium-vanadium [In-doped BiCaV] optoisolator"--passed technical accreditation on 6 May.

Technical indicators for the "long-wavelength In-doped BiCaV optoisolator" have met advanced international standards. The structure of a "single-mode optical-fiber polarization controller" is simple and the device is easy to adjust; insertion loss is low and the extinction coefficient is high. This is an important component in coherent fiber-optic communications systems and is used for adjusting the polarization state of the light output from a single-mode optical fiber and thereby to raise the sensitivity of the communications system. A "fiber-optic high-resolution delay auto/heterodyne [zi waicha] spectroscopic system" consists principally of single-mode fiber-optic delay line(s), a single-mode fiber-optic polarization controller, a single-mode fiber-optic directional coupler and an acousto-optic modulator; resolution is as high as 15kHz, and sensitivity is better than -14dB. These three scientific achievements were individually developed over a 5-year period by Wu Yizun [0702 1744 1415], Tao Shangping [7118 1424 1627], Li Ling [2621 3781], Jiang Peixuan [5592 0160 3872] and other [professors], along with their graduate students.

Status of China's Fiber-Optic Communications

Industrial Development

40080140a Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 1, Jan 89 pp 2-4

[Article by Office of Promotion of Electronic Information System Applications, State Council]

[Excerpts] Research on fiber-optic communications in China began in the early 1970's. Rapid progress has been made in recent years. Major accomplishments have been achieved in fiber-optic communications research and production, in urban telephone relay and in domestic fiber-optic demonstration projects. The following is an introduction to the development of the fiber-optic communications industry in China.

I. Development of Fiber-optic Communications in China

Before we introduce the development of fiber-optic communications in China, let us introduce the development of fiber-optic communications abroad. [Passage omitted.]

Research on fiber-optic communications in China has been planned by the State Planning Commission and State Science Committee. Some research institutes and higher-learning institutions are effectively conducting studies on various aspects such as theory, basic component and system design. As a result of technical efforts in the Sixth and Seventh 5-Year Plans, China has not only grasped DS1, DS2, and DS3 [2 Mb/s, 8 Mb/s, and 34 Mb/s, respectively] multi-mode long- and short-wavelength fiber-optic communications technology, but has also mastered major technology for single-mode fiber-optic communications at the DS4 rate (140 megabits/second, 1920 voice circuits). Encouraging results have been obtained in technical efforts toward high-speed fiber-optic communications systems at the DS5 rate (560 megabits/second, 7680 voice circuits) and at the 1.12 gigabits/second (15360 voice circuits) rate. The Chinese Government has supported pilot production lines and experimental routes which have effectively promoted the commercialization of fiber-optic communications in China. Production facilities capable of manufacturing DS2 and DS3 systems in China have recently been in operation. Several dozens ofplants continue to

improve the quality of the DS2, 3 and 4 equipment they manufacture and begin to show advantages in performance-to-cost ratio. There are over 100 organizations and 10,000 people (more than 50 percent technicians) engaged in research, teaching, design, production and construction in fiber-optic communications in China. They are primarily located in Wuhan, Shanghai, Tianjin, Beijing, Guilin, Xian, Nanjing, Chengdu, Chongqing, Huainan, Bangfu and Shijiazhuang. Wuhan, Shanghai and Tianjin are the three major bases for the development of fiber-optic communications in China. In response to needs in development and pushed by reform, inter-institutional and inter-regional manufacturing and construction companies have been established centered around core plants, research institutes and universities in major cities. In addition, various departments of the central and local government are very interested in building facilities for fiber-optic communications. Some plants have already imported technology or set up foreign joint ventures to manufacture optical fiber, optical cable, and optoelectronic terminals. The Chinese Government supports this approach because the healthy growth of a high-technology industry such as fiber-optic communications can only be possible by concentrating our resources. The policy of import, digest, develop and innovate can only be thoroughly implemented to improve quality and increase competitiveness by taking full advantage of the condition of opening up.

From the beginning, China noticed the importance of combining research and applications in fiber-optic communications so that technical achievements can be directly utilized in practice. In 1978, two years after the first practical fiber-optic communications line was put to use in Atlanta, China built its first outdoor digital experimental optical cable line in Guilin. In 1979, Beijing and Shanghai almost simultaneously introduced fiber-optic communications systems in their municipal public-telephone relay lines. Since then, fiber-optic communications systems have been adopted by various industries such as railroads, electric power, radio and television broadcasting, and mining. According to incomplete statistics, as of September 1988 China has built 10 long-distance trunk lines with approximately 1100 kilometers of optical cable. Approximately 2000 kilometers of optical cable are used as urban telephone relay lines in about 40 cities. There are three railroad-communications lines and 30 electric-power communications lines. More than 40 TV and radio stations, including the TV station in Lhasa, use fiber-optic transmission. Twenty-thirty businesses and several stations, harbors, warehouses, major urban thoroughfares and sozens of schools, research institutes and hospitals are using fiber-optic communications systems. The total length of optical cable in these special systems is approximately 2000 kilometers. It is estimated that more than 5000 kilometers of optical cable have been laid in total. Fiber-optic communications systems have been very effective in collecting and transmitting data in nuclear tests and in monitoring and controlling satellite launches.

Premier Li Peng is interested in the development of fiber-optic communications. After the State Council formed the Leading Group for the Promotion of Electronics Industry, he personally proposed the formation of a fiber-optic-communications subgroup to coordinate all available resources to push forward its research, production, importation and various applications.

Based on Li's instruction to follow the experience in promoting applications of satellite communications, the State Council agreed to select 15 projects in eight key areas of applications as key national demonstration projects in fiber-optic communications. Specifically, there is one primary public trunk line, i.e., the DS4 single-mode long-distance [146 km] trunk line from Hefei to Wuhu. There are three secondary public trunk lines: The DS3 multi-mode overhead optical-cable project from Wuhan to Jingzhou and Shashi [244.8 km] which has passed inspection [see JPRS-CST-88-016, 29 Aug 88, p 105], and the DS3 single-mode trunk lines between Yangzhou and Gaoyou [62 km] and between Chengdu and Guan Xian [64.6 km], which have been certified at the ministry level. There are three urban telephone relay projects and they are all DS4 single-mode systems; one of them is already operational in Wuhan [37 km long] and the rest are under construction in Shanghai [34 km] and Tianjin [length unknown; see also JPRS-CST-89-005, 23 Feb 89, p 84]. There are two projects in railroad communications, i.e. the Chongqing railroad-switching communications system and the Beijing to Baoding section [see FBIS-CHI-88-188, 28 Sep 88, pp 60-61] of the Beijing-Zhengzhou project. There is a project in radio and television broadcasting, i.e. the high-quality color transmission system at Qiqihar TV Station which has been satisfactorily inspected. There is one project in electric-power communications, i.e. the Baoji overhead and underground optical-cable communications system which is under construction. In addition, we have several projects on monitoring and control for industrial, transportation and security purposes. They include the multi-purpose fiber-optic transmission system at Anshan Steel and the Shanghai Municipality traffic-control fiber-optic video transmission system, both of which have passed inspection satisfactorily, as well as the Beijing TV optical-cable transmission system and Xichang Base TV optical-cable transmission system which are under construction. The experience acquired from these demonstration projects will significantly promote the domestic market. For instance, the secondary overhead optical-cable trunk line linking Wuhan, Jingzhou and Shashi provides an excellent example in rebuilding the 174,000-kilometer public open-wire communications network in China for its low cost, short construction period and high quality. The Ministry of Posts and Telecommunications held a meeting last June to promote it.

China is falling behind in communications. The telephone dissemination rate is 0.75 percent, which is approximately one twentieth of the world's average. It is even lower than the 1.4 percent worldwide average in 1921. The ratio of number of telephone sets to long-distance lines is seriously out of proportion. In other countries each long-distance line serves an average of 20-30 sets. In China, the number is 117. The entire country only has 53,000 long-distance telephone lines. Many new voice and non-voice services do not exist. However, this situation offers us an opportunity. Since stored program-controlled (SPC) exchanges and computers are becoming very popular in China, if advanced digital transmission means such as fiber-optic communications is adopted, we may be able to build a digital communications network directly using the latest technology which would bring us to the leading edge of modern communications.

In summary, fiber-optic communications has been used everywhere in China. Its applications involve all departments. Technically, China has grasped long- and short-wavelength DS2, 3 and 4 technology and has made considerable progress toward higher-rate systems. From the angle of operating procedures and development, demonstration projects are very effective. The fiber-optic communications industry has entered a key stage of widespread applications. China has a good foundation for developing fiber-optic communications. It is an area in high technology where the gap with the rest of the world is relatively small. Nevertheless, we must realize that the gap is still considerable. There is even the danger that the gap would widen. We still have many problems, including quality of optoelectronic devices, development of special integrated circuits, production problems, cost reduction problems, and fierce competition in the fiber-optic communications industry worldwide. These problems require thorough studies to be solved.

II. Major Policy in the Development of Fiber-Optic Communications

Several policy measures were introduced in the Chinese national fiber-optic communications workshop [see JPRS-CST-88-021, 10 Nov 88, pp 128-29]. They are:

1. Clearly identify fiber-optic communications as key point in the development of trunk lines. Overhead optical cables ought to be used in modernizing secondary overhead lines.

2. Include applications of fiber-optic communications in the national technology reform and promotion plan and provide certain incentives.

3. Adopt similar policy which applies to microelectronics devices and SPC telephone exchanges for the fiber-optic communications industry.

4. Encourage joint ventures between domestic and foreign companies to bid on construction contracts in order to accelerate the pace of development with the aid of foreign strength.

5. Strengthen control within the industry, speed up formulating standards and specifications, and implement systems such as production permit and quality assurance.

6. Make breakthroughs in the most important and weakest areas such as reliability and throughput of optoelectronic components, special integrated circuits for fiber-optic communications, and development and manufacturing of quartz wrapping and certain instrumentation.

7. Link this effort to the national high-technology research plan, concentrate resources to pursue new fiber-optic communications technology, keep track of world standards, and maintain strength for further development.

These measures are going to be implemented subject to approval by the State Council.

III. Speeding up Construction of Fiber-optic Communications Industry in China

Based on the above policy, existing foundation, and market demand, it is a strategic mission to rapidly build a fiber-optic communications industry in China. We must overcome difficulties to build up the capability to produce 50 to 60 thousand kilometers of fiber-optic communications systems per year by 1990 and take over a portion of the domestic market. By the year 2000 the production capacity should reach 300 thousand kilometers of fiber-optic communications systems per year to essentially satisfy the domestic market and to enter the international market. China has to pick up advanced technology and experience from other countries so that it can build a complete communications industry of its own. The growth must be coordinated according to proportion to gradually allow economic manufacturing to take shape. Lateral collaboration can be developed around key centers on a voluntary and mutually benefiting basis. Business entities and engineering corporations capable of handling various fiber-optic communications projects should be organized to include a variety of organizations engaged in research and development, design, and construction, as well as financial institutions. In addition, efforts should be made to bid on projects worldwide jointly with foreign manufacturers with an emphasis on providing labor to open overseas market.

It requires us to concentrate our resources, talents and technology to effectively develop a high-technology industry such as fiber-optic communications. Therefore, an overall plan is needed. The government must use a clear policy to regulate the market and let the market guide the industry. We must not allow one department or one region working on its own system to avoid dilution of capital, manpower and repetition. We have to introduce a competitive mechanism to stimulate us to develop our fiber-optic communications industry rapidly.

A review of the history of China's development of fiber-optic communications tells us that we have made significant progress in research, manufacturing and application. We have laid a good foundation for the future. Under the guidance of current policy, we are pushing for the wide application of fiber-optic communications in China in order to accelerate the building of a fiber-optic communications industry in China to meet the needs of economic growth and communications.

Present, Future Technology

40080140a Beijing DIANZI SHICHANG [ELECTRONIC MARKET] in Chinese 9 Feb 89 p 2

[Article by Huang Shijian [7806 0670 1017], senior engineer at the Institute of Intelligence, Ministry of Electronics Industry]

[Text] Engineering Development

China's research effort on fiber-optic communications began in 1972 within the Ministry of Electronics Industry. However, substantial progress was not made until the late 1970's. In 1979 the Shanghai Municipal Telephone Bureau

installed a 1.8-kilometer, 8.448 Mb/s relay line along Sichuan Road. The Beijing Bureau of Telecommunications installed a 3.1-kilometer, 8.448 Mb/s relay line between stations 86 and 89. By then, fiber-optic communications was in a trial stage, which put China four years behind other leading countries in the world.

To date China has installed over 240 fiber-optic systems. Among these 240 systems, there are 45 public network communications systems and 190 systems for dedicated communications. Approximately one half of the systems were imported and the other half were made domestically. The Chinese-made systems are primarily DS2 or 3 urban telephone relay systems with a total optical cable length of 450 kilometers. Only a few of them are trunk-line systems. The imported systems are mostly DS3 and 4 systems with a total optical cable length of over 900 kilometers. Hence, China has over 1,300 kilometers of fiber-optic communications systems in its public communications network. There are 1,400 kilometers of dedicated fiber-optic communications systems for radio and television transmission, industrial control, dedicated communications, and data communications.

Technical Level

Based on the above information if we do not take imported systems into account, all Chinese made fiber-optic systems are first- and second-generation systems. They are two generations and 7-8 years behind those in other nations.

As far as the technical level is concerned, we are even further behind in experimental systems as well as in individual technical issues. For example, China does not have an advanced single-mode system, has not begun research on heterodyne technology and wavelength-division multiplexing technique, does not have advanced optoelectronic devices, and has not made breakthroughs in single-mode optical-cable technology. The level of fiber-optic communications research is not much more advanced than that of the systems in China. This is another reason why fiber-optic communications cannot make rapid progress in China. To this end, research and development efforts are underway to work on advanced systems. DS4 systems have been certified and a DS5 system has been successfully developed in the laboratory. The development of more advanced systems is being planned.

Market Size

China is a vast country with a large population; it is lagging behind, however, in communications. The telephone dissemination rate is merely 0.72 percent. Specifying fiber-optic communications as a key technical development area signifies that fiber-optic communications has a large potential market in China. However, to quantitatively determine the size of the market will require the overall consideration of major factors such as synchronous development of the communications industry with the national economy, planning of public and dedicated communications networks, potential applications of fiber-optic systems in various communications networks,

the technical level of fiber-optic communications in China and our ability to develop such systems. The following is a semi-quantitative analysis of this question.

1. Optical Fiber Market for Relay Systems between Urban Stations

Based on the goal proposed by the Ministry of Posts and Telecommunications, China plans to octuple its capacity in telecommunications by the end of this century to raise the dissemination rate of telephones to 3 percent overall and 11 percent in the city. This requires an increase of 16,800,000 sets, 6,000 kilometers of optical relay cables and 24,000 kilometers of relay lines between stations. In view of the degree of maturity of fiber-optic communications in China, this industry should be built based on domestically manufactured systems. In addition, it is expected that this technology will be mature in China in 1990; 30 percent of the relay lines to be built before 1990 will use fiber-optic systems and 60 percent of the new lines to be built after 1990 will be fiber-optic. In total, there will be 16,000 kilometers of fiber-optic relay systems. Assuming each relay line has 6 fibers (two pairs of primary and one pair of spare), we need 96,000 kilometers of optical fibers. Historically, the ratio of dedicated to public networks is 3:7; 6,900 kilometers of relay cables will be needed for dedicated networks, corresponding to 13,400 kilometers of fiber. The combined need between public and dedicated networks is 22,900 kilometers of cable, or 107,400 kilometers of fiber.

2. Optical Cable Market between City and Suburb

Based on our urban development plan, each major city in China has several satellite towns. For example, Beijing has close to 20 satellite municipalities. Each satellite has 20,000 telephones. By the year 2000 we have to install 400 long-distance lines. Let us assume that each line is 50 kilometers; this totals 20,000 kilometers. Since most of these satellite towns will be built in the Ninth 5-Year Plan, it is expected that most of them will be fiber-optic. The plan will require 100,000 kilometers of optical cables, or 600,000 kilometers of optical fiber.

3. Subscriber Optical Cable Market

The subscriber market is a growth area in other countries. However, communications in China lag behind. We do not believe that ISDN [integrated services digital networks] and LAN [local networks] networks will be popular by the year 2000. Nevertheless, we must proceed with the experiment. It is estimated that tens of thousands of kilometers of optical fiber will be required. Once ISDN's and LAN's become popular, the demand for optical fiber will be substantial.

4. Long-Distance Trunk-Line Market

Long-distance trunk lines include national and provincial lines.

Based on the plan, China must build at least 20,000 kilometers of trunk lines between 1990 and 2000. Economically speaking, we should use fiber-optic systems if possible. In the Ninth 5-Year Plan, it is estimated that optical-cable technology will become mature in China. If optical cable is used at 80 percent, it requires approximately 16,000 kilometers. If there are 8 fibers per cable, this corresponds to 128,000 kilometers of fiber. Similarly, at the 3:7 ratio, we need 51,000 kilometers of fiber for dedicated networks. The sum is 128,000 + 51,000 = 179,000 kilometers of fiber.

Optical-cable systems ought to be used in provincial trunk lines after 1990. Each province will install 1,000 kilometers of cable between 1990-2000. Based on 20 developed provinces, we will need 20,000 kilometers of cable, or 120,000 kilometers of fiber.

In total, we need 16,000 kilometers of 8-fiber cable and 20,000 kilometers of 6-fiber cable, or a total of 299,000 kilometers of fiber.

5. Undersea Optical-Cable Market

China has a long coastline and numerous islands. It is estimated that 16 coastal cities need to install 6,000-7,000 kilometers of underwater cables. Optical cables may be used. It is also assumed that optical cables will be used to connect the islands to the mainland and each coastal province will need 100 kilometers. There are 7 [coastal] provinces and cities for a total of 700 kilometers. The sum of these two items is [about] 7,500 kilometers of (6-fiber) optical cable, corresponding to 45,000 kilometers of fiber.

Total Need

Based on the above rough estimates in various areas, China will need approximately 1,100,000 kilometers of optical fiber between 1985-2000. Of course, this estimate will fluctuate quite a bit with the degree of maturity of fiber-optic communications. In addition, the demand will be much higher toward the latter part of this 15-year period. In the Seventh 5-Year Plan, the rate of gorwth in fiber-optic communications has been slow. We primarily have relied on imports rather than domestic products. Based on the plan adopted by the Ministry of Posts and Telecommunications, construction of 72 fiber-optic communications projects is scheduled, including 52 urban telephone relay lines and 19 long-distance trunk lines. In these 72 projects, there are 18 DS4 and 32 DS3 projects. A total of 5593.4 kilometers of optical cable will be required. This is equal to 19 times that used in the Sixth 5-Year Plan. Approximately 80 percent of the optical cable will still have to be imported.

In view of the fact that the capacity and technical level of the optical fiber produced in China cannot meet our needs, various departments and areas are purchasing production lines from abroad or are engaged in joint ventures. However, as far as we know, these production lines will produce more than our demand. For instance, the line imported by the Shanghai Optical Fiber

Corporation has a capacity of 100,000 kilometers of fiber per year. The production line in Xiamen also can produce 100,000 kilometers of fiber per year. The line acquired by the Ministry of Posts and Telecommunications can produce 20,000 kilometers of fiber per year. Dalian plans to set up another line with an enormous annual capacity. Thus, we are creating a situation where supply will exceed demand.

Current State of Satellite Communications Development

40080140b Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 1, Jan 89 pp 9-10

[Article by Yang Xueming [2799 1331 6900]: "Current State of Development in Satellite Communications in China"]

[Text] Since we decided to lease the international communications satellite (Intelsat-V) to broadcast television programs and organized satellite communications in China in 1985, satellite communications has gone through both start-up and development stages. On 7 March 1988, China successfully launched a geosynchronous satellite fixed at 87.5°E, "Chinasat-1," from Xichang Satellite Launch Base. On 22 December 1988, we launched another communications satellite fixed at 110.5°E. The launch of these two satellites has enabled us to have simultaneous access to transponders on international and Chinese satellites. This sig ifies a new era in satellite communications. The following is a brief introduction of our recent development.

I. Current State of Satellite Communications in China

Generally speaking, domestic satellite communications includes the broadcasting of television and radio programs and domestic satellite communications involving Posts and Telecommunications and other specialty departments. As of the end of 1988 the state of satellite communications is as follows:

1. Television Broadcasting

Domestic television broadcasting is the fastest growing business in China in the past few years. Since we began to rent transponders on an international satellite to broadcast television in 1985, because of the high quality of the transmission, freedom from geographic restrictions, and low cost in constructing ground reception stations, satellite television broadcasting has grown quite rapidly from one to seven channels. They are channels 1 and 2 of the Chinese Central TV Station and channels 1 and 2 of the Chinese Central Educational TV and three local TV programming stations in Xinjiang, Guizhou and Yunnan.

In addition to developing satellite coverage of multiple programming channels, the number of ground reception stations has been increasing at a fast rate. It is estimated to have surpassed 6,000 by the end of 1988. Remote rural areas, border areas and all major cities can receive various TV programs from central and local stations in real time.

2. Domestic Satellite Communications within the Ministry of Posts and Telecommunications (MPT) and Other Specialty Departments

As of the end of 1988, MPT has five major ground stations: Beijing, Guangzhou, Urumqi, Lhasa, and Hohhot. MPT also has seven small stations: Tongliao in Inner Mongolia; Qamdo, Shiquanhe, Nyingchi, and Xigaze in Tibet; and Yining and Hotan in Xinjiang. All the stations are operational. Except for the Beijing station, which has an 18.3-meter-diameter antenna, all major stations have 12-meter-diameter antennas. The small stations have 6-meter antennas. We are using both the SCPC (single channel per carrier) and FDMA/CFM (frequency division multiple access/companded frequency modulation) modes for domestic satellite communications. In addition, there are special circuits for transmitting weather data. Furthermore, using the equipment developed by Qinghua University and Zhenhua Corporation, a 2.048 Mbit/s [i.e., DS1] digital circuit-group-modulated circuit is in service between Guangzhou and Urumqi. This is the beginning of digital communications using satellite in China. Besides offering telephone and telegraph services, a 64 kbit/s satellite circuit developed by Beijing Institute of Posts and Telecommunications and Hangzhou Communications Equipment Plant is being used for newspaper facsimile transmission between Beijing and Urumqi. This signifies the beginning of digital facsimile transmission of newspapers.

In 1988, all specialized departments are maintaining last year's level in satellite communications. This involves the 15 satellite networks for the Ministry of Petroleum Industry centered at Gu'an [Hebei Province], the satellite communications [link] between Antaibao station and Beijing for various coal-related departments, and the networks dedicated to the Ministry of Water Resources and Electric Power. Other departments are in the planning and construction phases.

3. Arrangements for Satellite Transponders

Since there are at most five transponders suitable for China's domestic communications on an international communications satellite and there are only four transponders on the satellite we launched, it is not possible to have the same satellite handle both television broadcasting and other communications. Based on the resources available, the assignment of transponders is shown in Figure 1. These services are assigned on the 66°E-longitude international communications satellite, and the 87.5°E-longitude and 110.5°E-longitude satellites, respectively. Since we are limited by the number of transponders, local television transmission in Xinjiang, Yunnan and Guizhou cannot have dedicated transponders. We are taking advantage of the time difference between Xinjiang and Beijing. The local TV programming in Xinjiang follows the first set of programming

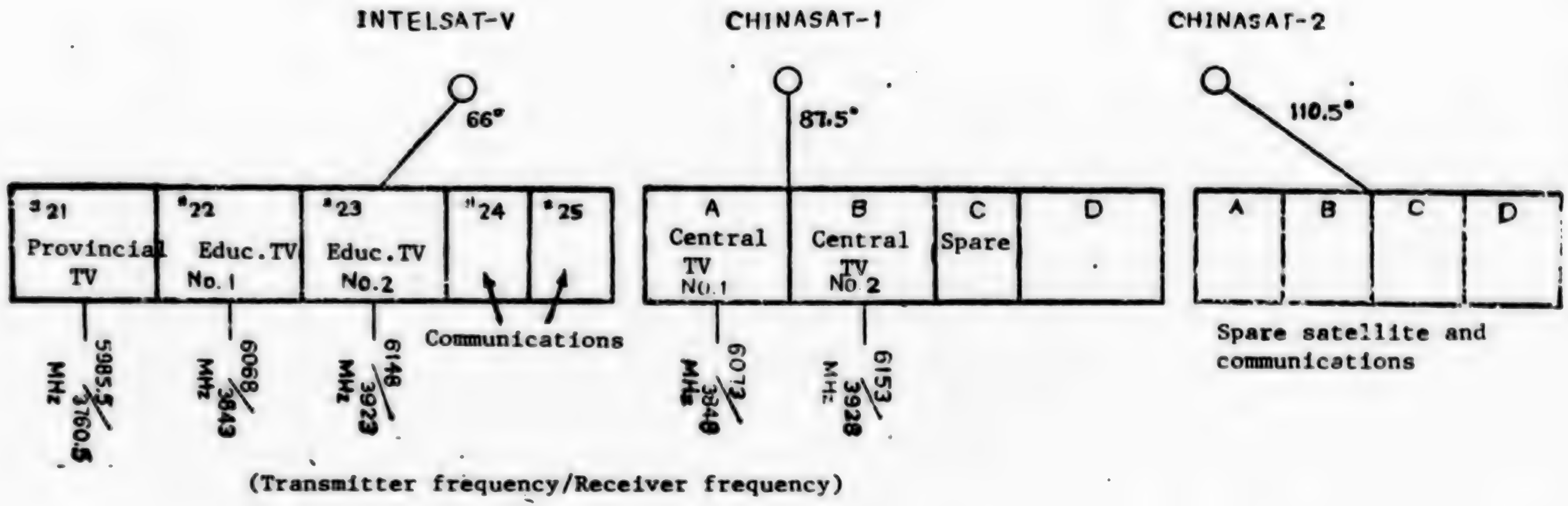

Figure 1. Satellite transponder allocations

of the Chinese Central TV Station in order to share the same transponder. Yunnan and Guizhou share the same satellite transponder to transmit programs at different time periods. In the future, this arrangement may be adjusted due to various factors as different services grow.

II. Current State of Domestic Satellite Communications Technology

The state of international satellite communications technology has been described in the past. The following is a brief introduction to the current state of major technology in domestic satellite communications.

1. Table 1 shows the major technical specifications of Chinasat-1.

Table 1

initial orbital mass	459 kg
end-of-life power	300 W
equivalent isotropic radiated power (EIRP)	32 dBW (edge)
number of transponders	4
operating frequency bands	uplink: 5925 - 6425 MHz downlink: 3700 - 4200 MHz
fixed point accuracy	$\pm 0.1°$ (E-W, N-S)
beam direction error	N-S 0.6° E-W 0.4°
beam polarization	linear polarization transmission: perpendicular to spin axis reception: parallel to spin axis
saturated transponder output power	10 W
receiver noise coefficient	5 dB

2. The downward coverage of its communications antenna is shown in Figure 2 [not reproduced]. The picture shown in the figure is a view of the earth centered around the fixed satellite coordinate. The center of the beam of the satellite at 87.5° is pointing at Maqu in Gansu Province. The

equivalent isotropic radiated power (EIRP) in the area is 36dBW. From Figure 2, the EIRP value is above 32dBW in most of China's territory.

III. Outlook and Plan for Domestic Satellite Communications in China in 1989

The plan for domestic satellite communications in 1989 primarily includes the following areas:

1. Further increase in the capacity at stations already constructed by MPT to take full advantage of the economic benefits. Based on the plan, the capacity at the five major stations (Beijing, Guangzhou, Urumqi, Lhasa, and Hohhot) will be expanded. This will provide the conditions necessary to establish satellite circuits with other major stations under construction. In the meantime, MPT will begin construction of three large ground stations in Chengdu, Chongqing and Qingdao. In early 1989, the 11-meter-diameter antenna at Kashi (Kaxgar) station in southern Xinjiang [Province] will be completed. In addition, nine other small stations, including the Kuqa station in Xinjiang, Zhangmu Port station in Tibet, Hailar station and Ulan Hot station in Inner Mongolia, Sanya station on Hainan Island, and Yongxing Island station in the Xisha Archipelago, are under construction and will become operational soon.

2. Satellite transmission of local TV programming in Tibet will be increased. The People's Government in the Tibet Autonomous Region is building the No 2 Antenna at the Lhasa station. It is expected to be completed in 1989 for satellite transmission of local TV programming to improve TV and radio broadcasting in the region.

3. Acceleration of the construction of small satellite data communications systems. In order to satisfy the needs of data transmission in various departments, in addition to the existing small data-transmission system offered by the China Broadcast Satellite Corporation, the Beijing Municipal Telecommunications Administrative Office of MPT is building a satellite-based small data communications system.

4. Importation of new technology in satellite communications. Based on an agreement between the governments of China and Canada, Canada will provide a grant to MPT [for the latter] to import some time-division multiple access (TDMA) satellite communications technology, including a number of pieces of TDMA equipment. It is expected to accelerate the pace toward digital satellite communications.

In conclusion, satellite communications is in a vigorous development phase in China. As new ground stations are completed, new technology imported, and China's capability to manufacture equipment associated with satellite communications is strengthened, the domestic satellite communications industry will make a significant contribution to the development of TV broadcasting and to the realization of modern communications.

Estimate of Maximum Instantaneous Distortion at Outlet of Inlet

40090052a Beijing GONGCHENG REWULI XUEBAO [JOURNAL OF ENGINEERING THERMO-PHYSICS] in Chinese Vol 10 No 1, Feb 89 pp 25-28

[English abstract of article by Liang Dewang [2733 1795 2489], et al., of Nanjing Aeronautical Institute]

[Text] In this paper, a new statistical method for estimating the maximum instantaneous inlet pressure distortion is described. By this method, the time average and RMS values of the instantaneous pressure distortion index can be obtained theoretically from the measured inlet total steady-state pressure and RMS values. The most probable maximum instantaneous distortion index occurr'ng in a given duration can also be obtained. A comparison between the estimated values and the experimental results shows that the described method can accurately estimate the maximum instantaneous distortion index to within 3 seconds on an Intel 86/330 microcomputer.

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Variational Principle with Variable Domain Discontinuous Finite Element Method for Transonic Flow, Determining Automatically Position, Shape of Shock Waves

40090052b Beijing GONGCHENG REWULI XUEBAO [JOURNAL OF ENGINEERING THERMO-PHYSICS] in Chinese Vol 10 No 1, Feb 89 pp 40-42

[English abstract of article by Zhu Zhiguo [2612 3112 0948], et al., of Shanghai Institute of Mechanical Engineering]

[Text] In this paper, the theory of the variational principles with variable domain suggested in Reference 1 is applied. The discontinuous finite element model is made which can determine automatically and exactly the position and shape of the shock wave in two-dimensional transonic flow pass while the velocity and density are jumping on both sides of the shock wave. Accurate results are obtained and compared for an exact solution to a wedge of inlet Mach number 1.2.

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Lattice Vibrations, Force Constants of Cu(100), (111), (110) Surfaces

40090050a Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 349-356

[English abstract of article by Luo Ningsheng [5012 1337 0524], et al., of the Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy of Sciences]

[Text] The authors previously obtained the semiempirical functions for describing the interaction properties in the Cu ground state by using the Embedded Atom Method (EAM). In this work, the formula for surface force constants between planes is derived and the force constants between planes of the Cu (100), (111) and (110) surfaces are then calculated, demonstrating that the EAM can distinguish the differences found in interatomic interactions in the bulk and near the surface, and can also distinguish the differences among interatomic interactions occurring near different structural surfaces. The calculated force constants lead to good agreement between the projected state densities of the surface vibrations calculated by the Recursion Method and the experimental results of electron-energy-loss-spectroscopy.

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Study of GaAs(110) Surface Relaxation with Low-Energy-Electron-Diffraction

40090050b Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 357-365

[English abstract of article by Lan Tian [5663 3944], et al., of the Department of Microelectronics Technology and Electronic Materials, Chengdu Institute of Radio Engineering]

[Text] The authors have studied the surface relaxation of GaAs (110) with low-energy-electron-diffraction. They find that the best agreement between theory and experimentation is obtained for a structure in which the As atoms are tilted outward by 0.10 ± 0.02 Å and the Ga atoms are tilted inward by 0.55 ± 0.02 Å, with an angle of rotation (ω) of 27.32° ± 0.24°, keeping the bond length at surface As-Ga unchanged, the Ga to second-layer spacing d_2 = 1.45 ± 0.01 Å and the second-layer Ga to third-layer spacing d_3 = 2.01 ± 0.01 Å. For this structure, the As back bond length l_{As} = 2.43 ± 0.01 Å (contracted 0.56 percent) and the Ga back bond length l_{Ga} = 2.235 ± 0.004 Å (contracted 8.0 percent).

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Electron Subbands, Wave Functions of Type-I, Type-II Quasiperiodic Semiconductor Superlattices

40090050c Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 366-375

[English abstract of article by Qin Guoyi [4440 0948 3015] of the Laboratory of Solid State Microstructures; Center of Theoretical Physics, Nanjing University]

[Text] The envelope function approximation was generalized to calculate the electron subbands and wave functions of quasiperiodic semiconductor superlattices (QSS), within rational approximation, for nonzero $K_{\perp}$ (the wave vector perpendicular to the axis of the QSS).

For $K_{\perp} = 0$, the electron subbands and wave functions are calculated for InAs/GaSb QSS up to the generation number $m = 9$, and for $GaAs/Al_xGa_{1-x}As$ QSS up to $m = 6$. For InAs/GaSb QSS, the influence of the valence band states on the conduction band state is strong. The dependences of the energies and bandwidths of the electron subbands on $K_{\perp}$ are obtained for $m = 5$ and 6. A theoretical method is proposed to calculate the intersubband collective excitations of the type-I QSS by means of the above results.

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Current Transport Mechanism in Thermally-Nitrided SiO_2 Thin Films

40090050d Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 376-384

[English abstract of article by Zheng Xueren [6774 1331 0088], et al., of the Department of Physics, South China University of Technology, Guangzhou]

[Text] A new trap-assisted two-step tunneling model is proposed to explain the conduction enhancement characteristics and conduction mechanism in heavily-nitrided oxide films. A theoretical calculation is carried out to fit the theory to the experimental results. The trap density and trap energy level are found to be in the range of $1.2 \times 10^{19} - 7.2 \times 10^{20}$ cm^{-3} and 2.46 - 2.56 eV, respectively. These results agree satisfactorily with the Auger spectroscopic data. In addition, this model can also be applied to MNOS structure or MIS devices with other traps.

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Transfer Function Theory for Fluorescence Dynamics

40090050e Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 422-429

[English abstract of article by Huang Shihua [7806 0013 5478] of Changchun Institute of Physics, Chinese Academy of Sciences; Lou Liren [2869 4539 0086] of the Department of Physics, University of Science and Technology of China, Hefei]

[Text] In order to characterize the dynamic properties of a fluorescence system under a weak excitation regime, the fluorescence response function and fluorescence transfer function are introduced. Based on these concepts, a new theoretical representation of fluorescence dynamics is established. It is then applied to a discussion of some important problems. The results show that the new theory provides an effective method of systematically describing the fluorescence dynamics of complex systems in which energy transfer processes take place.

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Transfer Characteristics of Nonradiative Energy from Tb^{3+} to Ce^{3+} in Yttrium Gallium Garnets

40090050f Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 430-438

[English abstract of article by Liu Xingren [0491 5887 0088], et al., of Changchun Institute of Physics, Chinese Academy of Sciences]

[Text] Selection-excited spectra and fluorescence lifetimes of Tb^{3+} and Ce^{3+} ions in yttrium gallium garnets are obtained at room temperature. In $Y_3Ga_5O_{12}$:Tb, Ce, the Tb^{3+} (donor) emission spectrum and Ce^{3+} (acceptor) excitation spectrum overlap considerably. The observed fluorescence lifetimes of the Tb^{3+} $^5D_3$ and $^5D_4$ levels decrease with the Ce^{3+} concentration when the samples of $Y_3Ga_5O_{12}$:Tb, Ce are excited by an UV laser pulse. The mechanisms for nonradiative energy transfer from the $^5D_3$ and $^5D_4$ states of Tb^{3+} to the $^2D_{3/2}$ state of Ce^{3+} are found to involve electric dipole-dipole interaction. The critical distance, rate and efficiency of energy transfer from the Tb^{3+} to the Ce^{3+} ions are obtained. The average critical transfer distance (R_0) for $^5D_3$ and $^5D_4$ $(Tb^{3+}) \rightarrow {}^2D_{3/2}$ (Ce^{3+}) is 16.3 Å and 11.2 Å, respectively. Although the energy transfer from the $^5D_4$ state is dominated by the dipole-dipole interaction, the dipole-quadrupole interaction must also be taken into consideration.

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Real-time Compensation of Atmospheric Turbulence by Nonlinear Optical Phase Conjugation

40090050g Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 466-470

[English abstract of article by Wang Xiaochun [3769 2556 2504], et al., of the Department of Precision Instruments Engineering, Tianjin University]

[Text] A theory of compensating for atmospheric turbulence by optical phase conjugation is developed based on the transmission theory of the monochromatic scalar wave through the atmosphere and the first Born approximation. It is shown, under the conditions of the nonabsorbing atmosphere and an infinite phase conjugate mirror, that atmospheric turbulence can be corrected thoroughly. The authors' experiment demonstrates that the optical phase conjugate wave generated by SBS can restore the initial optical field in real time.

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Transport Properties of Tetragonal, Orthorhombic Phase in $YBa_2Cu_3O_{7-x}$ System

40090050h Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 3, Mar 89 pp 511-515

[English abstract of article by Ruan Yaozhong [7086 5069 6988], et al., of the Department of Physics, University of Science and Technology of China, Hefei]

[Text] The resistance and thermoelectric power were measured for a series of single phase $YBa_2Cu_3O_{7-x}$ samples with different quenching temperatures. The relationship between the thermopower and temperature indicates that there exists a phonon-drag peak in the orthorhombic phase sample. The peak disappears in the tetragonal phase sample. This phenomenon suggests that the electron-phonon interaction influences the superconductivity of $YBa_2Cu_3O_{7-x}$. According to the experimental data of thermoelectric power, estimates of the Fermi energy and carrier concentration of the sample are made.

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Debugging Completed on First In-Line Isotope Separator

40080165c Beijing ZHONGGUO DIANZI BAO in Chinese 11 Apr 89 p 1

[Article by Yue Haikui [1471 3189 1145]]

[Text] The off-line debugging of China's first in-line isotope separator has recently been successfully completed. This important experimental equipment for research in nuclear physics has a resolving power that meets advanced international standards for equipment of like kind. Independently designed and developed by the Chinese Academy of Sciences' [Lanzhou] Institute of Modern Physics, the equipment is [in place as] one of the experimental-physics terminals connected in-line with the Lanzhou Heavy-Ion Accelerator and may be adapted for nuclear spectroscopes and laser spectroscopes.

Uses of the device include synthesis of new nuclides, research on differentiation and new decay modes, research on laser spectroscopy, and measurement of nuclear ground-state parameters. In addition, the equipment can be joined to a mass spectrograph for direct measurement of nuclear masses, to provide information on nuclear structures. This new equipment will be an ideal aid for research in nuclear physics, atomic physics, solid-state physics, astrophysics, and biophysics.

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